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HOWARD V. BROWN

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Cold Light

WE have pointed out before in these columns how utterly wasteful our present methods for obtaining light are. We have mentioned the fact that the coal which we burn to obtain electricity is nearly all wasted, and that we realize less than one per cent in light, of the energy contained in coal.

What then are our prospects of producing "cold light" in the near future? There are three so-called sources of cold light of which we know today. These sources are purely physical, and do not include cathode-ray effects of the Geissler tube type or Cooper Hewitt light variety. These latter are not to be classed in the "cold light" category because the light produced in either of these tubes is not really cold in the true sense of the word.

The three sources that can give rise to cold light are the following: Luminescence, Fluorescence and Phosphorescence. Luminescence can be derived from a large number of substances which become luminous under the influence of light, also due to ignition, etc. In nearly all cases luminescence occurs with a simultaneous rise of temperature, and for this reason it really cannot be termed "cold light." When we take a diamond and heat it moderately, it becomes luminous. This fact has been known for a long time, and this is one variety of luminescence. Calcide, too, when heated becomes luminous and remains so in the dark for hours, even if the heat has been discontinued.

In contra-distinction to luminescence we have fluorescence. Fluorescence is a lighting phenomenon which takes place only as long as the source of light is directed upon the substance. The fluorescence disappears immediately when the original lighting source is discontinued. Fluorescence for that reason is due to the absorption of certain light rays. A peculiar phenomenon of many fluorescent substances is that they give out rays of light of a different color than the substance itself. For instance certain green crystals of fluorspar give off blue light, etc.

Next in order we have phosphorescence, in contradistinction to fluorescence. The difference between the two is that phosphorescence persists after the source of light has been removed. Thus for instance calcium sulphide gives off light after it has been exposed to sunlight and continues to do so for some time in the dark. Many substances such as barium sulphide, strontium sulphide, etc., when exposed to ultra-violet rays or X-rays, will continue to emit a soft light for hours in the dark.

Phosphorescence is also found to a very large extent in many living organisms such as are found in sea water; they very often cause the sea to become phosphorescent for miles. It is now thought also that the fire-fly and many other insects such as the glow-worm, etc., all owe the origin of their luminosity to phosphorescence. Recent researches also tend to show that the photogenic apparatus of these insects contain certain fats, which latter contain free phosphorus. Oxygen in the air when coming in contact with this fat produces the characteristic phosphorescent flashes or glow.

It should be noted that with the possible exception of the phosphorescence, the other sources of cold light would be just as difficult to exploit economically as coal is today. From this it will be seen that not much progress has been made towards the ultimate realization of cold light commercially.

H. GERNSBACK.

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paid for novel experiments; good photographs accompanying them are desirable.

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Science and Invention

H. GERNSBACK - EDITOR
H.W. SECOR - ASSOCIATE EDITOR

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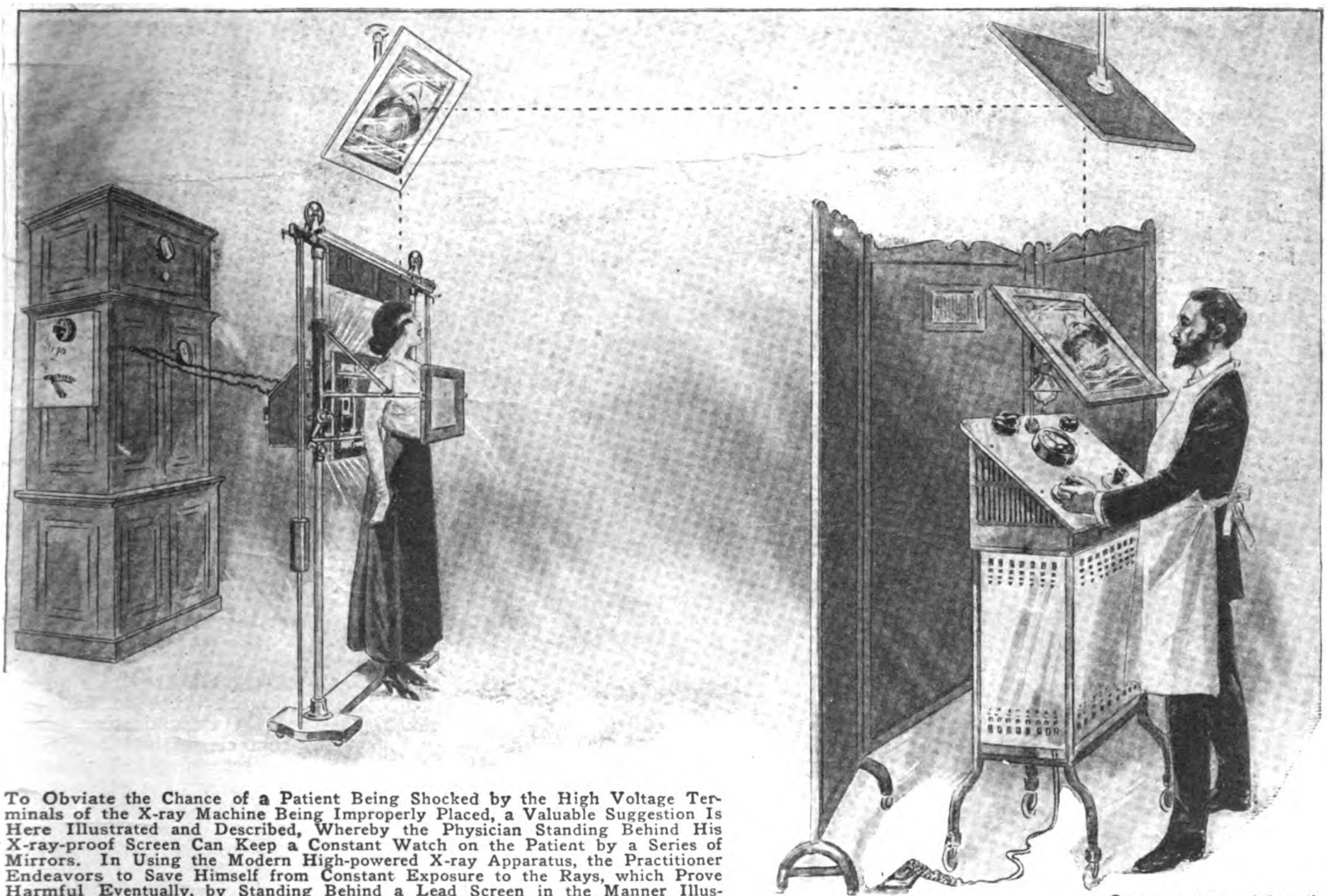
Eliminating Danger from X-Ray Machines

IN the old days of the X-ray, when induction-coils were used before the advent of the modern high powered machines, which invariably use alternating current high-voltage transformers instead of such induction coils, there was very little chance of a patient being ball to his head with only a momentary, altho severe shocking effect.

Recently a patient was electrocuted in the office of a physician at Newark, N. J., while the physician's son-in-law, who claimed to be an expert in the operation of the X-ray machine, was in the act of taking skiagraphs ploying a system of mirrors. The first or viewing mirror, is placed directly over the patient, so that the X-ray operative can at all times note just what is going on all around the patient's body and be sure that the wires connecting to the X-ray tube and other parts of the machine are sufficiently



To Obviate the Chance of a Patient Being Shocked by the High Voltage Terminals of the X-ray Machine Being Improperly Placed, a Valuable Suggestion Is Here Illustrated and Described, Whereby the Physician Standing Behind His X-ray-proof Screen Can Keep a Constant Watch on the Patient by a Series of Mirrors. In Using the Modern High-powered X-ray Apparatus, the Practitioner Endeavors to Save Himself from Constant Exposure to the Rays, which Prove Harmful Eventually, by Standing Behind a Lead Screen in the Manner Illustrated, and This "Mirror" Idea Should Prove a Valuable Adjunct Toward Safety.

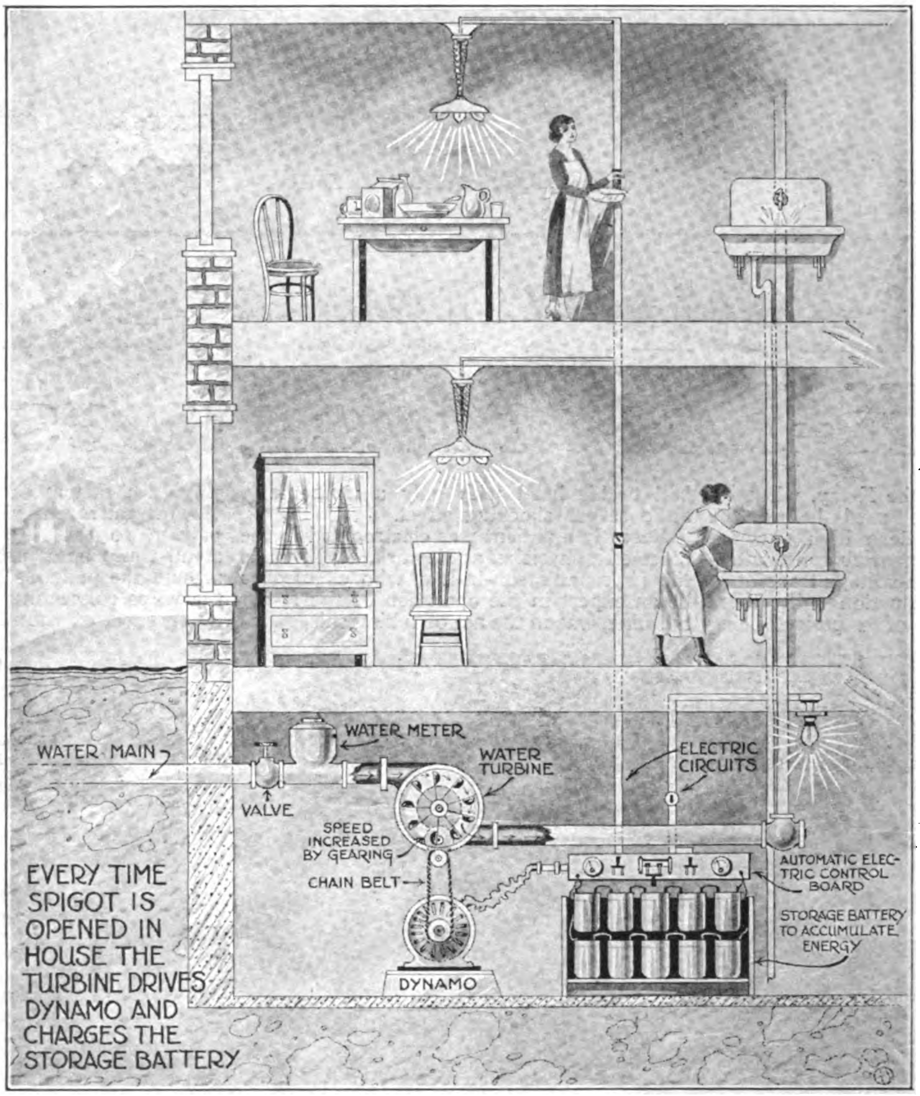
electrocuted or killed, even if a wire had come near enough to the body to permit a spark to jump. This was due to the fact that the spark discharge, even from large induction coils, is of such a peculiar nature that rarely, if ever, has it proven fatal to human life.

The writer knows of one case where an electrician was testing a large spark coil capable of giving an 8-inch discharge, when the primary was accidentally closed, while the inspector's head was approximately between the two discharge balls, with the consequence that a spark jumped from each of the patient's jaw and teeth. The coroner finally came to the conclusion that it was not the fault of the doctor or his assistant that the patient succumbed, even tho a part of the electrical wires or X-ray tube stand had come close enough to the body to admit of a spark jumping to the patient's body, and causing his death,—but that the patient whose medical history was known, suffered from a weak heart, gastritis, and other ailments conducive to a weak condition of the cardiac system.

The accompanying illustration shows an idea suggested by Mr. H. Gernsback, employing... distant from the body, and that no sparking takes place, which may indicate the improper arrangement of the apparatus.

As in the case of the Newark physician where the fatality occurred, it is the usual practise for those owning a large size and extremely powerful X-ray machine, to step behind a lead screen as here shown in order to protect themselves from the X-rays as much as possible, owing to their frequent daily exposure to the rays which eventually are liable to prove harmful. These screens are invariably fitted with a small lead-glass window which cuts off the X-rays.

Electric Lights From Spigots



A French Scientist Has Successfully Tried Out and Demonstrated in His Own House That It Is Possible to Operate Your Electric Lights at No Cost Whatever, Providing You Have City Water or Water Under Pressure Distributed Thru Spigots in the Usual Manner. This Scientist Has Fitted a High-Speed Water Turbine on His Water Supply Pipe, in a Manner Like That Shown Above—This Turbine Drives a Dynamo Which Charges a Storage Battery. It Is Simply Utilizing Energy Wasted Every Day, Declares This Genius.

EVERY house with its own electric generating installation is the dream which M. E. Colardeau, French scientist, expounded before the French Academy of Sciences recently. "We Waste Too Much Energy," was his text, and he proceeded to show how scandalous was *waste*.

Wind power was wasted wholesale, but even more culpable was the waste of waterpower within one's own house. "The force of every kitchen and bathroom tap is wasted," he declared, and he put forward a scheme which he believes can be made practicable to utilize the force from the water that runs from every kitchen tap, which Paris derives from a reservoir 200 feet above the city.

This is where M. Colardeau's invention comes in. In his own house he has fixt on his supply pipe a high speed water turbine, geared directly to a dynamo, with a little battery of accumulators or storage battery. Every time that the taps are turned on the little generating station works and the batteries accumulate the energy from the water. With his own installation the scientist claims he can light 1 500-candlepower lamp, or 20 lamps of from 15 to 20-candlepower.

Our illustration herewith shows a home - generating plant installed in a building housing several families. To take advantage of the various spigot openings when in use at different times, the water turbine is placed in the cellar near to the water meter. The turbine is geared up to the main driving shaft, which is connected mechanically to the dynamo with a link belt or chain. Automatic cut-outs or circuit breakers open the dynamo circuit whenever the speed and consequently the voltage of the latter fall below that necessary to pass current into the battery.

In his house he uses no other installation, and it never gives out and never costs him anything. In the country places M. Colardeau would use the wind to pump water up to the required heights, and so transfer the wind energy into water energy, which would be transformed into electric energy.

"When we've done that," he concluded, "we needn't any longer worry about the exhaustion of our coal stocks."

Helium

By John T. Bushby

THE recent announcement by the United States Geological Survey of unlimited supplies of helium gas in the vast oil reservoirs of Texas, does not surprise the devotees of science, simply because the phenomenal of yesterday is the commonplace of today. Coupled with this, the statement of Professor McLennan, the distinguished Canadian scientist, on the floor of the House of Commons, Ottawa, a few weeks ago, excited little comment when he said that the city of Calgary alone has been wasting fifty million dollars' worth of helium daily during the war, along with its natural gases.

The Canadian West is remarkably prolific in natural gas. A few years ago Rudyard Kipling, while on a visit to the town of Medicine Hat, called it "the city that was born lucky," because natural gas produced all the heat, light and power in the place, including that used in the big central machine shops of the Canadian Pacific railway. Every street lamp in town was lit by natural gas which burned all day because it was cheaper to keep the lamps lit, than to pay for matches to relight them. Thus the quantity of mixed helium that went up the flue will never be known. More inefficiency.

The economic value of helium centers in the fact that it is the ideal gas for dirigible air-ships. It is slightly heavier than hydrogen, but unlike hydrogen it is absolutely non-inflammable, *ergo* had the big Goodyear dirigible been filled with helium instead of hydrogen, the recent appalling holocaust in Chicago would have been averted.

The spectrum of helium was observed not only in the sun, but also in many of the stars; and in some classes of stars now known as helium stars the spectrum of helium predominates. Helium, which was named by Lockyer, has a well marked complex spectrum of bright lines, of which the most noticeable is a bright yellow line close to the minutely separated sodium lines.

No evidence of the existence of helium on earth was discovered until 1895. Hillebrande of the U. S. Geological Survey no doubt found it on analysis of radio-active rocks found near Glastonbury, Conn. He thought it was nitrogen, altho it differed in behavior from ordinary nitrogen. The mineral clevite gave off large quantities of gas when heated or dissolved. Ramsay procured some of this mineral in order to see if it might be argon, which he had previously discovered. On examination of the gas liberated from clevite into a vacuum tube, he found a spectrum entirely different from argon. The spectrum was carefully examined by Lockyer and found to be identical with that of the element helium, previously observed by him in the sun.

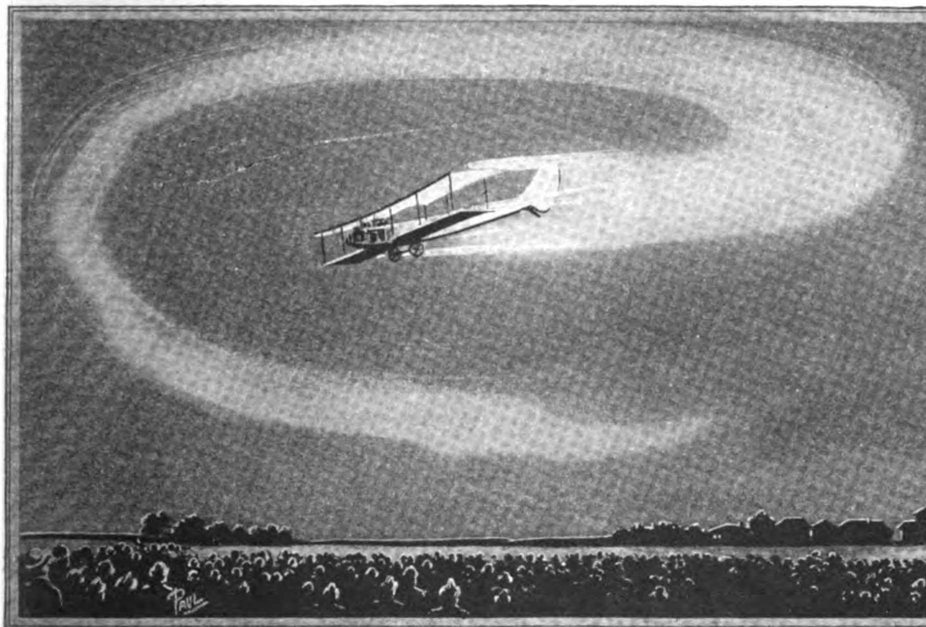
Thus, after a lapse of 27 years since its discovery in the sun, helium had at last been found to exist on the earth. Ramsay and Soddy, in 1903 discovered that helium seems to be continuously produced from radium and other radio-active substances; but this phase includes a literature of its own, too extensive for description here. Suffice to say, that two more elements, coronium and nebulum, are known to exist in the sun, which have not yet been found on earth. But there are gaps in Mendelejeff's table of periodicity waiting for the computation of their atomic weights.

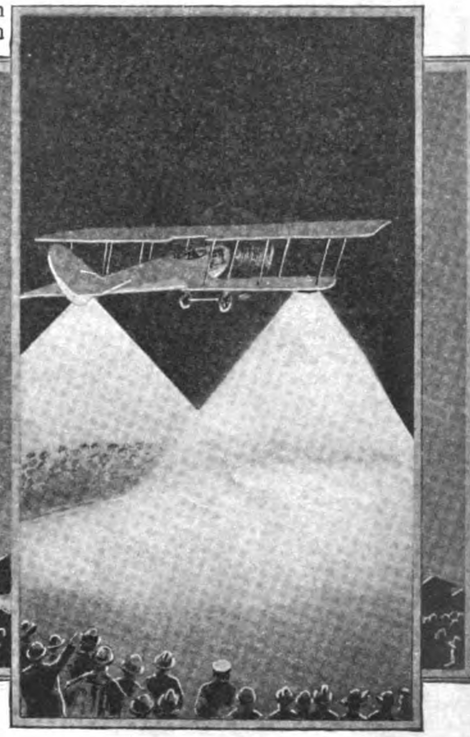
Who will be the lucky prospector to locate them? Perhaps some electrical experimenter or radio bug, tinkering in garret or woodshed, and now unknown to fame!

Torch-Lit Plane Lands at Night

WINGING his way to earth from a height of 5,000 feet in an airplane ablaze with flaming torches, which, reflecting on a series of mirrors attached to the under wing, illumined the landing field with a daylight refulgence, Paul Collins, an aviator, thrilled a crowd of spectators at Hazelhurst Field, near Garden City, N. Y., recently when he demonstrated the practicability of landing in the darkness and of fireproofing aircraft. In the glide to the ground the swiftly moving plane resembled a comet with its long-drawn-out tail of fire. The plane used in the test was a Curtiss, to which had been attached more than a dozen reflecting mirrors underneath the lower wing. On the tips of the wings magnesium flares had been placed connected to the pilot's seat by electric wire, by which they were set off. On other parts of the airplane torches such as are used on Fourth of July were tied.

No better night for such a demonstration could have been asked. The field was in total darkness when Collins "took off" with only his green and red head and tail lights showing. Ascending to a height of about a 1,000 feet, when the sight of the plane was lost to the spectators in the darkness, Collins touched off the torches on either side of the fuselage. In an instant the whole plane was bathed in a flood of fire, and residents of Garden City, who during the war had frequently seen ill-fated aviators falling in a mass of flames when the wings took fire, must have thought that a recurrence of that type of accident had happened. Around and around the plane sped at a rate of eighty miles an hour, ascending until a height of 5,000 feet was reached. In the upward and onward flight the flaming tail seemed to be at least a hundred feet long. When at a height of about 1,000 feet he touched off the magnesium torches which reflected on the mirrors. The whole field, hitherto dark, became as broad daylight. An examination of the wing fabric and woodwork of the airplane showed that it was none the worse for having been subjected to the fire from the flares.





One of the Most Wonderful Sights Ever Beheld Was Recently Witnest at Hazelhurst Flying Field, Long Island, When a Daring Aviator Successfully Demonstrated the Practicability of Landing with Torches and Also Tested the Efficiency of a New Fire-Proofing Scheme for Aircraft. Reflecting Mirrors Were Placed Underneath the Lower Wing and Magnesium Flares Reflected in the Mirrors When These Were Lighted; These Flares Illuminated the Whole Field Which Became as Bright as in Broad Daylight.

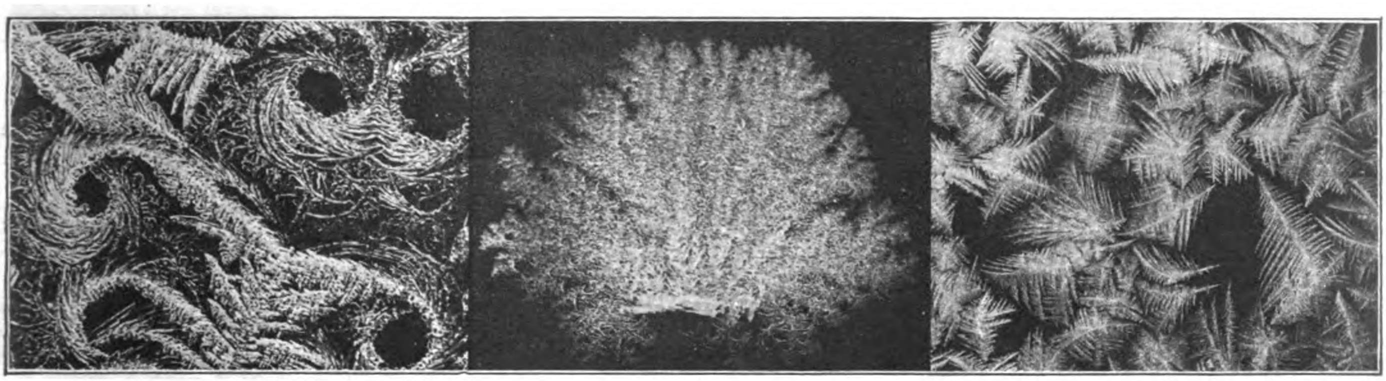
Wonders of "Jack Frost"

By JEROME LACHENBRUCH

WHEN you rise, shivering, on a cold winter morning and your window panes are covered with frost, do you ever stop to think of the wondrous beauty that has come to your room during the night?

If your eyes had the magnifying power of the common house fly, you would see a variety of designs on your window that would startle you with the exquisiteness of their forms. Frost crystals may take various forms. The most common is that of the fern leaf, which it resembles not only in shape, but also with a suggestion of texture. Sometimes, frost crystals form in imitation of the animal kingdom, when they shape themselves in a series of intertwined ostrich feathers. And again, they may follow the suggestion of the ocean world by taking the form of a fan-shaped coral.

The accompanying photographs were taken under a microscope and have been transferred by a unique process to the motion picture screen. They will be shown in educational and other institutions thruout the United States.—*Courtesy Bray Studios.*



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Some True Wonders of "Jack Frost": Illustration at Left Shows Frost on Window Pane Resembling Intertwined Ostrich Feathers. Again Jack Frost May Follow the Suggestion of the Animal Kingdom by Taking the Form of a Fan-Shaped Coral (Center). The Most Common Frost Design Found on Window Panes Is That of the Fern Leaf Shown Very Beautifully at Right.

A Fairyland of Bubbles

By JOSEPH H. KRAUS

PROBABLY there is no one who has ever played with soap bubbles who has not often wondered at the beautiful colors and entrancing effects obtained by these soap films. Incidentally, each one of us has felt a desire, during some period of such experimentation, to obtain a permanent film which would preserve for us the gorgeous effects so often noted.

Many of us have also been present at lectures in which the operator dexterously manipulated soap films so as to present to us spectacular effects which we had never dreamt of. Wire frames immersed in soap solutions produce the most fantastic and unique impressions. The writer has experimented with films of this nature for quite a time, the object being to produce a film which when formed, would last indefinitely.

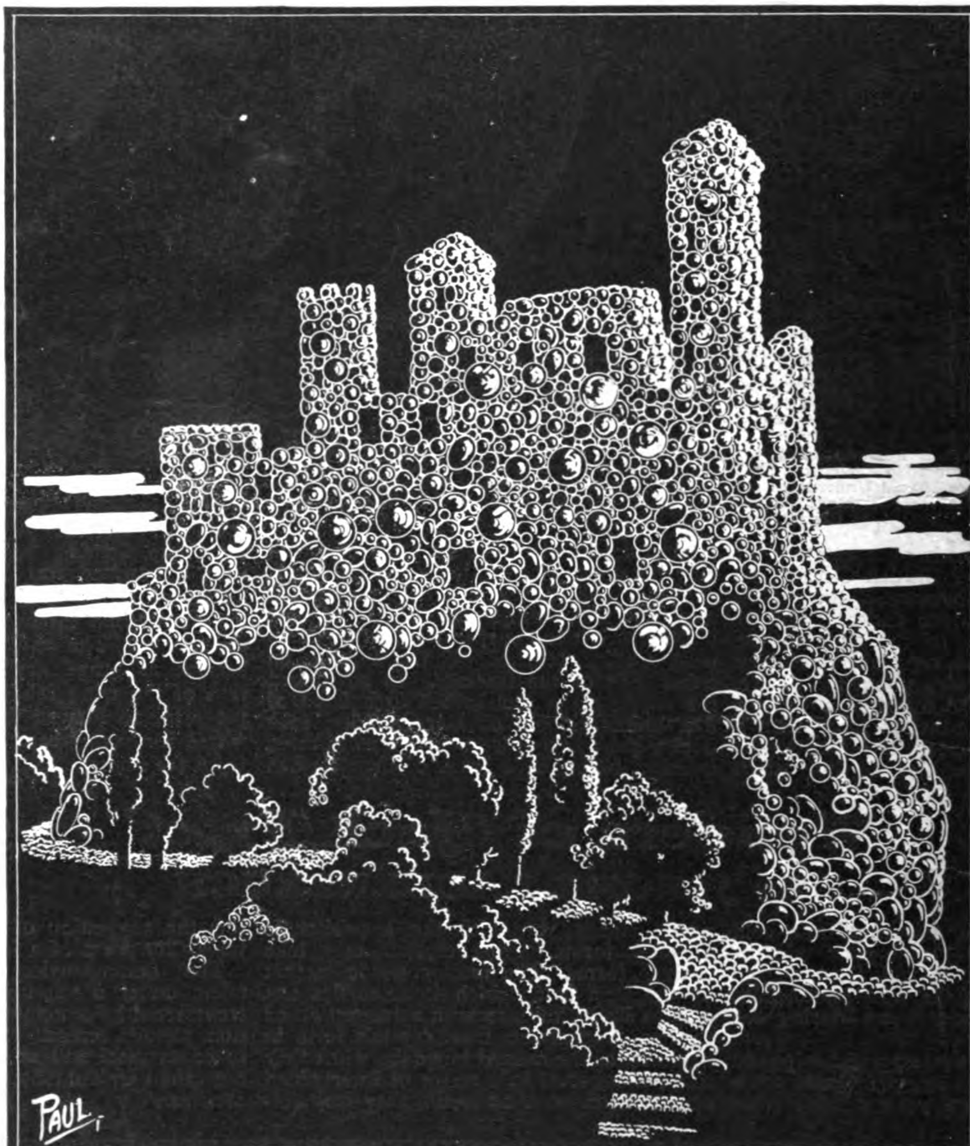
At first, the experiments were rather discouraging, but finally the film was floated on water so that the delicate tissue could be lifted up on a wire frame. Here, after allowing it to stand for one week, it developed the most exquisite refraction effects imaginable, and the interference colors developed seemed to improve even upon Nature.

Making the Solution

This effect can readily be produced with a little care by any experimenter in the following simple manner: Three ounces of amyl acetate are purchased from the local druggist and placed in a four-ounce vial. Ordinary celluloid which may be obtained by immersing pieces of camera film in boiling hot water to remove the emulsion, is then cut up into narrow strips and introduced into the vial, until the height of the liquid therein comes up to the neck of the bottle.

It is allowed to stand for twenty-four hours at room temperature with the bottle corked and then the supernatant liquid which is of quite a heavy consistency is poured into another bottle and is ready for use. The mode of procedure is to make a loop or circle three inches across by twisting a piece of copper wire together, leaving about eight inches of wire to act as a handle. This handle is then bent into such a shape that it will not interfere with the removal of the film.

A good way to do this is to place the circle upon a table and bend the handle downward over the edge of the table. This curve is then changed by twisting it outward and then upward as shown in our diagram. The wire circle is afterward immersed in a bowl of water and a single drop of the amyl acetate and celluloid solution is allowed to fall into the water; the drop instantly spreads over the surface of the water and forms a film and floats on the water. It will be seen that at first very pretty iridescent colors form near the edge of the film. These colors gradually spread, which spreading can be forced by blowing at the surface of the film.



Altho It May Sound Quite Impossible, a Wonderful Castle Such as the One Here Shown, May Be Constructed Entirely of Permanent, Colored Soap Bubbles After the Manner Described in the Accompanying Text. The Art of Blowing Permanent Soap Bubbles Which Will Last a Year or More, Opens Up an Entirely New Field of Experimentation for Those Interested in Scientific Matters. By Flashing Colored Lights on to the Bubble Structure, Either from Behind or in Front, Very Beautiful Effects Are Readily Produced.

Removing the Bubble Films

After a short period, the surface becomes serrated and the serrations become more prominent as the experiment proceeds. Finally, when the largest of these serrations has become about one-half an inch long, the wire frame is centered under the film and lifted carefully, in this way removing the film intact.

It will be found quite difficult to succeed at first, and it is best to start with smaller frames, but after a while quite large films can be removed without difficulty. These are suspended in some location free of dust and within a week the film will develop a very interesting interference effect which can be projected thru an ordinary stereopticon upon the screen.

The tension of this film can be demonstrated by the fact that if the blunt end of a pencil is held in an upright position in contact with the film, considerable force will be required to puncture the surface, the film easily taking care of the weight of the pencil, and not allowing it to penetrate unless prest upon.

Another way of demonstrating the tension of the film is to tie a piece of thread to the wire circle. The free end of the thread is tied into a loop about an inch across. The thread is held out of the water and the film is produced as just described. Then the loop on the thread is placed upon the floating film. The film is lifted as described and a hole is punctured thru the center of the loop; the loop flies open into a perfect circle and the tension of the film is demonstrated.

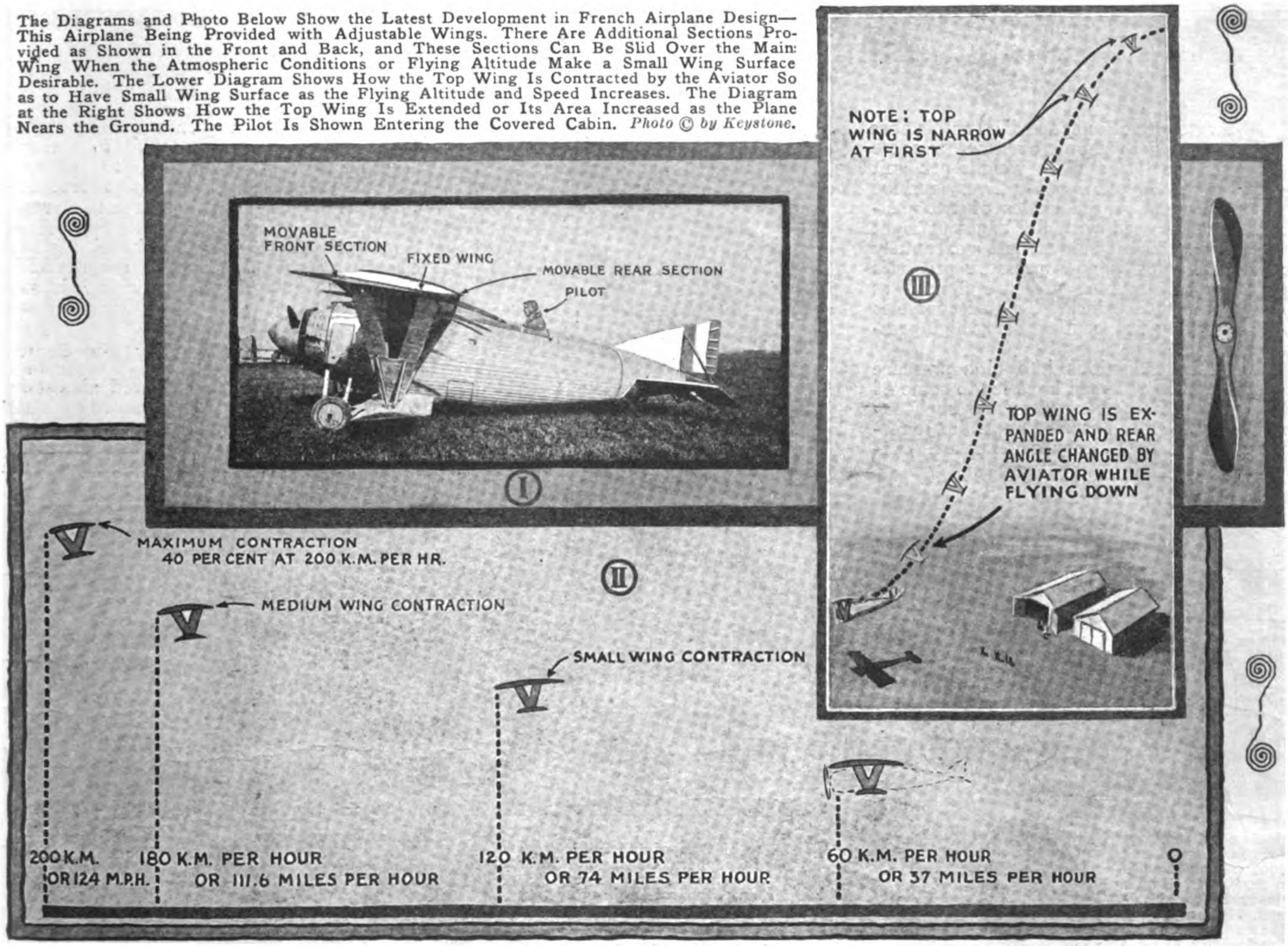
A hole punctured in the film with a sharp needle also gives a very clever demonstration of the film tension. So much for films of this nature, which must, of course, be made in the flat form altho they are capable of assisting in the regular experiments in surface tension. It has been found that a film of this form, if sprinkled with lycopodium or some other light powder, will show definite zones whenever a musical instrument is played in its vicinity, giving a Chladin plate effect. These areas are differently marked with each sound.

Now we come to the more difficult object,

(*Continued on page* 1024)

Airplane Varies Wing Spread in Flight

The Diagrams and Photo Below Show the Latest Development in French Airplane Design—This Airplane Being Provided with Adjustable Wings. There Are Additional Sections Provided as Shown in the Front and Back, and These Sections Can Be Slid Over the Main Wing When the Atmospheric Conditions or Flying Altitude Make a Small Wing Surface Desirable. The Lower Diagram Shows How the Top Wing Is Contracted by the Aviator So as to Have Small Wing Surface as the Flying Altitude and Speed Increases. The Diagram at the Right Shows How the Top Wing Is Extended or Its Area Increased as the Plane Nears the Ground. The Pilot Is Shown Entering the Covered Cabin. *Photo © by Keystone.*



BEFORE the Military Commission at Etamps (France) a successful demonstration was recently made with an airplane of which the wing surface can be increased or diminished during flight and the speed proportionately varied. The plane was designed by Levavasseur and Gastambode and flown by the aviator, Grandjean, after whose demonstration of its capabilities it was officially accepted by the commission.

The machine is a 250-horse power biplane in which a new mechanism enables the pilot to vary the wing surface from thirty to fifty square meters and alter his speed from 60 to 200 kilometers an hour. The surface variation is made in the upper plane, which is constructed in three parts. One of these is fixt, but the two others are movable, one gliding forward and the other backward. The centre of pressure is kept invariable by giving the forward and rear wings a different displacement.

The pilot starting out with the wings at full stretch rose to a considerable height. Then wishing to increase his speed he began contracting the wings' surface. The operation took about a minute, during which time the plane gathered speed until it was flying at 200 kilometers an hour.

When he wished to land, the airman again increased the surface and glided down gently at 60 kilometers an hour and made a perfect landing. The arrangement of the rear wing of the upper plane enables the pilot, at the same time as he expands it, to alter the curvature or angle at which it is set and so present a greater or less resistance to the air. The landing, under the circumstances, resembles almost exactly that of a bird, which at the same time that it decreases the speed bends its wings to a different angle to break the force with which it touches the ground.

Military experts who saw the exhibition declare themselves well satisfied that a great step is made by the invention toward securing safety in the landing of an airplane which can at the same time be capable of great speed. The mechanism is both simple and strong and the trials carried out showed not the slightest fault.

Universal Electric Farm Motor

Wherever electric central station lines are extended into rural districts or private lighting plants are installed, there is felt an immediate need for a small portable motor which may be available for operating the miscellaneous light machinery always to be found about the country home and farm.

The small electric motor here illustrated is furnisht especially for this apparatus and is supplied to operate on 60-cycle, single phase, 110 volt or other potential, circuits from central station service, or else 32 volt direct current service as supplied by the average farm lighting plant, driven by water-wheel or gasoline engine.

Universal Electric Farm Motor, Which Can Be Operated from Any Lamp Socket, Driving Churn.

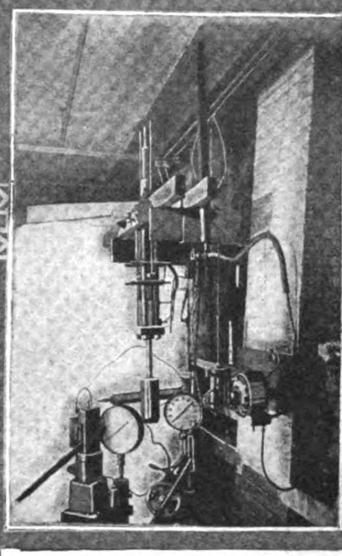
The motor is mounted on a steel tripod base provided with a brace rod and clamp for maintenance of proper belt tension. The motor is equipt with a back gear which reduces the pulley speed to 285 r.p.m., a speed suitable for driving the butter-churn, washing machine, grind-stone, pump and other devices of this class without making it necessary to equip them with pulleys of large and small diameter, which of course entails considerable complication where a small motor only is used for operating the machine.

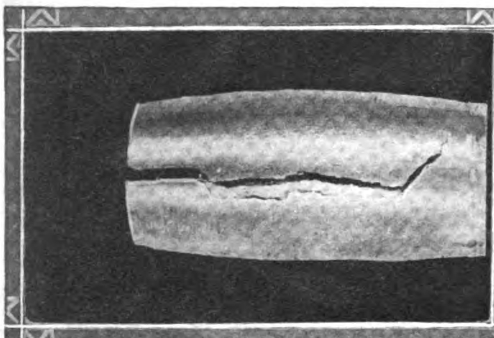
A third special pulley is supplied as shown, with two spaces for round belts and one for flat belts.

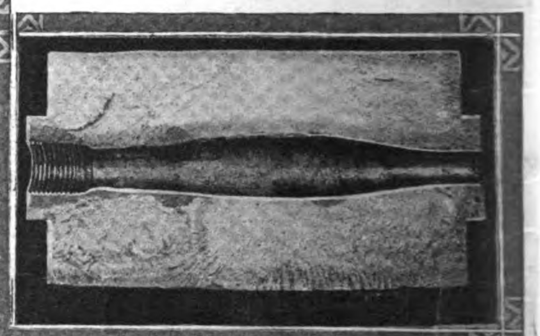
Wonderful Experiments in High Pressure

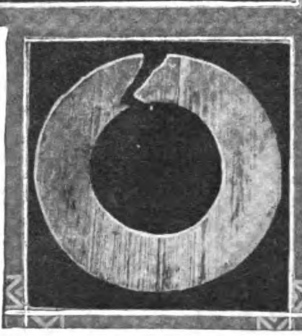
AS rate of motion is specified as distance covered in a unit of time, pressure is usually rated in weight per unit area. This brings about very curious results. If the blades of two pen-knives are crossed with the edges at right angles, the area of contact is so extremely small that a few pounds pressure produces an enormous rate of pressure figured at pounds per square inch. This of course is only a striking way of illustrating high pressure.

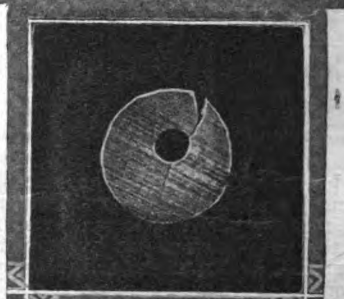
Recent investigations into high pressure by Dr. P. W. Bridgman have led to some of the most interesting results; and such experiments are being carried on in the Jefferson Physical Laboratory of Harvard University.











Half a Million Pounds Pressure per Square Inch Results in Strains in Metals Never Before Realized. Photo Above Shows a Cylinder Cracked by High Internal Pressure.

Cross-section of Shell Ruptured by the Application of High Internal Pressure. The Inner Hole Was Stretched from ½" to 1⅜".

View of One of the High-Pressure Cylinders, Gages and Other Paraphernalia Used in the Jefferson Physical Laboratory at Harvard University by Dr. P. W. Bridgman. In the Famous High Pressure Experiments Conducted by Dr. Bridgman, Pressures Were Carried Up to Ten Times the Firing Pressure of Smokeless Powder in Large Guns; in Other Words, Pressures of 300,000 Pounds per Sq. In. Were Obtained, and New Kinds of Ice Heavier Than Water Were Discovered.

Photo Above Shows One of the Halves of a Cylinder of Tool Steel Split by the Application of High Internal Pressure. The Inner Hole Was Stretched from 1/2" to 1 1/5". The Maximum Pressure Withstood Was 30,000 Atmos.

Section Cut from a Copper Cylinder Split by the Action of High Pressure.

In the Bridgman experiments pressures were carried up to ten times the firing pressure of smokeless powder in large guns. A pressure of 20,000 atmospheres, or in round numbers 300,000 pounds to the square inch, or 150 tons, was attained; this represents the pressure which would be exerted at the bottom of a body of water 120 miles deep. It would take a column of rock some fifty miles high to exert this pressure on its base.

The pressure was produced in a cylinder provided with a piston packed with packing which grew tighter with the pressure. The piston has to stand a strain of compression and for it the best material was found to be hard tool steel. It was found that it could sustain a pressure of from 600.000 to 750,000 pounds per square inch, a surprisingly high figure. When it came to the cylinder it became a question of tensile strength. It was found that the best treatment was to apply to the unfinished cylinder a higher pressure than it was intended to sustain. This stretched the interior. It was then put on the boring engine and brought to its final diameter. It will be observed this represents the condition attained by a gun over whose inner tube the great hoops and jackets are shrunk on. When a strain is applied to said cylinder by high pressure in its interior, a state of uniform tension approximately is produced thruout the metal of the cylinder. This state is the one which gun constructors strive to reach in the building-up or wire-winding process. Chrome vanadium steel, oil hardened, was found the best for the cylinder.

Most extraordinary results were reached. A cylinder half an inch in internal diameter was stretched to over an inch in diameter before breaking, and the break, when the cylinder was ruptured, started at the outside. Of course the object was to use the cylinders without breaking them, and the stretching and peculiarity of fracture noted are side issues only.

Paraffin Wax More Rigid Than Steel!

Substances ordinarily soft and pliable were found to increase in rigidity under pressure. Paraffin wax at 20,000 atmospheres becomes more rigid than soft steel. A piece of soft steel bedded in paraffin which is made to flow under this pressure will go with the stream and become bent and distorted with the wax now harder than itself.

Soft India rubber becomes so brittle that it ill crack like glass, and becomes harder than soft steel, so that irregularities on its surface can be imprest upon the surface of the metal.

A pressure gage of the simplest possible description, which consisted of a small diameter barrel with a piston moving freely yet fitting tightly, was found to measure high pressure with an accuracy of one-tenth of one per cent. This was treated as a master gage and with it electrical resistance gages were calibrated. Such gages consisted of coils of manganin wire, whose electric resistance changes in proportion to the change in pressure to which it is subjected.

Water Compress Twenty Per Cent.

Water is generally considered almost incompressible, but under a pressure of 12,000 atmospheres the astonishing decrease of volume of twenty per cent was produced. Certain irregularities in the behavior of the water induced the experimenter to believe that he was sometimes measuring liquid water and sometimes ice. Of course it was not easy to tell what was going on inside of the heavy steel cylinder.

Under these pressures when water freezes to ice it decreases in volume and the pressure falls; and when ice melts to water the volume increases and the pressure rises. Sudden changes of pressure were taken as indicating the formation of ice or of water. For every temperature the pressure at which water freezes becomes different. It is a sort of case of critical temperatures and pressures.

New Kinds of Ice Discovered!

From the work of a previous experimenter, it was known that there are two distinct varieties of ice produced under the condition of high pressure. Two additional ones were found in these last experiments, so that we know of five different kinds of ice, four of them of higher specific gravity than water.

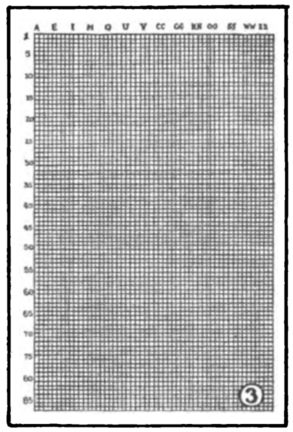
In some cases, on high compression, ice changes into another kind with such suddenness as to suggest an explosion. In other cases, the change would sometimes take hours before its completion; the lower the temperature as a rule, the slower was the change from one ice into the other.

(*Continued on page* 1008)

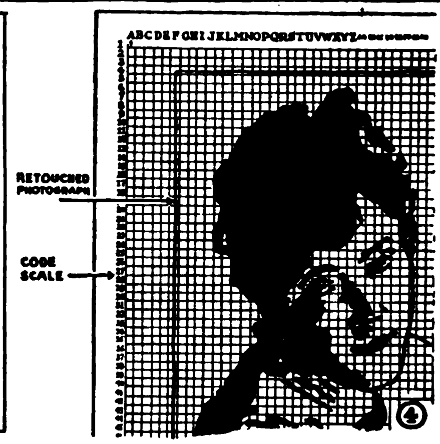
Telegraphing Photos by Code

PHOTOGRAPHIC PORTRAIT

SAME PICTURE, RETOUCHED INTO LINE DRAWING



CODE SCALE ON CELLULOID TRACING CLOTH OR PAPER (1/3 ACTUAL SIZE)



CODE MESSAGE NECESSARY TO TRANSMIT PORTRAIT: HAIR AND CONTOUR X6 TO Z, W7 TO Z, Q8 TO U, V8 TO Z, O9 TO T, U9 TO BB, O10 TO BB, N11 TO Z, SS TO DD, M12 TO AA, BB TO DD, ETC.

The Above Pictures Show Successive Stages in a New Method Evolved for the Transmission of Photographs or Other Pictures by Code, Over Telegraph or Telephone Circuits, as Well as by Radio or Cable. The Original Photograph at Left Was First Retouched or Redrawn So as to Resemble a Line-Cut, as Shown at Fig. 2. A Transparent Code Scale (3) is Then Placed Over the Line Cut as at 4, and the Black and White Portions of the Picture Coded by Noting the Lines Which the Black Portions Intersect.

THERE has been evidenced of late an unusual interest, especially by the lay public, in the frequent reports from Europe that certain inventors, notably Belin and Andersen, have been successful in transmitting pictures over a telegraph or telephone wire.

The Belin system was described at length in the November issue of this journal, and M. Belin is now in this country making preparations for transmitting photographs and drawings, as well as writing, over an ordinary telephone circuit, by means of his rapid transmitting and recording instrument which he has perfected to a high degree.

Before discussing the new Andersen system recently demonstrated in London, by invitation of the London *Daily Express*, which method involves the coding and decoding of a given picture, drawing or script, by means of numbers, let us glance at Fig. 1-A, which shows a highly magnified half-tone picture of a man's head. This represents an enlargement of a plate made for printing in a magazine such as SCIENCE AND INVENTION or any other periodical, and in the original of which the dots constituting the picture were so small, that they could hardly be distinguished by the naked eye.

Now to show the correctness of the dot or point theory of picture construction as employed in the half-tone process, all you have to do is to place this magnified dot picture of the man's face about six feet away, when you will be surprised by the result; the dots all merge into one another in a very mystical way, and yet in a manner well-understood by photo-engravers, to form a natural likeness of the subject.

The numerous inventors who are developing systems for transmission and reproduction of photographs, etc., are almost invariably working along these lines, utilizing the fact that with fairly fine points or dots, or in some cases lines, a satisfactory picture can be reconstructed at the receiving end of the circuit. This fact can be demonstrated in the manner just explained in connection with viewing the cut at Fig. 1-A, at a considerable distance. In the event that the cut should be reconstructed by the receiving instrument or by decoding a cablegram or telegraph message composed of numbers indicating the positions of the various dots, lines, etc., of the original picture in a coarse manner or by large dots, the picture can be suitably reduced so as to give a faithful reproduction of the photo or picture in question.

This Picture of a Man Demonstrates Vividly How Accurately a Picture Can be Constructed, Solely from Black Dots. Hold This Picture at Arm's Length and the Features of the Man Will Begin to Form; Look at It from a Distance of 8 to 10 Feet, and You Will be Astonished at Seeing the Features Fully Developed. Figure 1-A.

Changing Photos to Line Cuts for Transmission by Code

It is reported in a recent dispatch from London that the young Danish inventor, Thorvald Andersen, has devised an entirely new system of transmitting and reproducing photographs over long distances, which system has great promise.

His arrangement of the details, it is said, makes it possible to telegraph, telephone or radio a photograph as far as either of the electrical circuits his system employs may extend, which means, of course, across the ocean, or across the U. S.

The London *Daily Express,* who invited the young Danish inventor to demonstrate his system in England, recently publisht three photographs cabled from Denmark across the North Sea to the London office of that paper. These three pictures were those of King George, Lloyd George and Irene Vanbrugh, the well-known English actress.

A unique feature of this demonstration of the Andersen system was the fact that the three photographs selected by the editor of the London *Daily Express* were picked out from a number of photographs after the inventor had started on the journey from Copenhagen to London, and were transmitted via the Andersen system by his brother in Denmark. When the inventor arrived in London, the three cablegrams in code from his brother awaited him

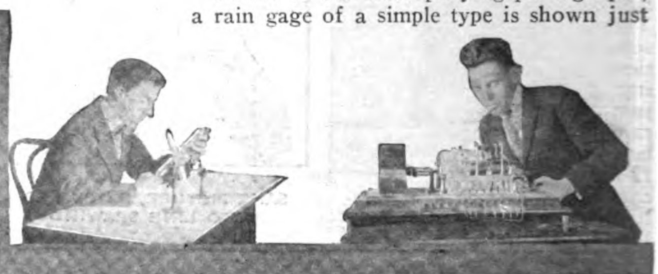
(*Continued on page* 1010)

Science and the Weather Man

How Rain, Sun and Wind Are Accurately Measured

IN the days of the past and bygone generations our forefathers looked at the weather-cock to determine the direction of the wind, scanned the sky knowingly morning and evening, and exchanged comments as to what their ideas of the weather during the following twenty-four hours would be. Some farmers today still cling to the old-fashioned way of telling the weather by placing a miniature doll's house on their porches and they believe that when the doll in pink appears at the door of the house the weather will be fair, but if the doll in blue should be seen—then rainy weather is in store for us.

Two Important Factors in Forecasting the Weather Scientifically are "Air Pressure" and "Wind Velocity." The Barograph and Anemometer Feel and Record These Quantities. The Four Cups of the Wind Speed Indicator and Recorder Rotate in the Breeze.



The Picture Above Shows a Weather Bureau Expert Holding a Glass Tube Device Known as the "Sunshine Recorder."

At Left: Prof. C. F. Marvin, Chief of the U. S. Weather Bureau, With His New Self-recording Weather Observation Instrument. It Has Been Successfully Tested by Attaching It to a Box Kite.

Photo at Extreme Right Shows Weather-recording Meteorograph or Triple Register, Which Electrically Records the Direction and Velocity of the Wind, the Amount of Rainfall and the Sunshine.

The United States Weather Bureau was founded by a resolution approved February 9, 1870. Today there are 200 branches of the Weather Bureau in the United States. Besides these there are 4,500 cooperating stations. Every main branch of the Weather Bureau is supposed to be able to predict for an area of 1,500 square miles.

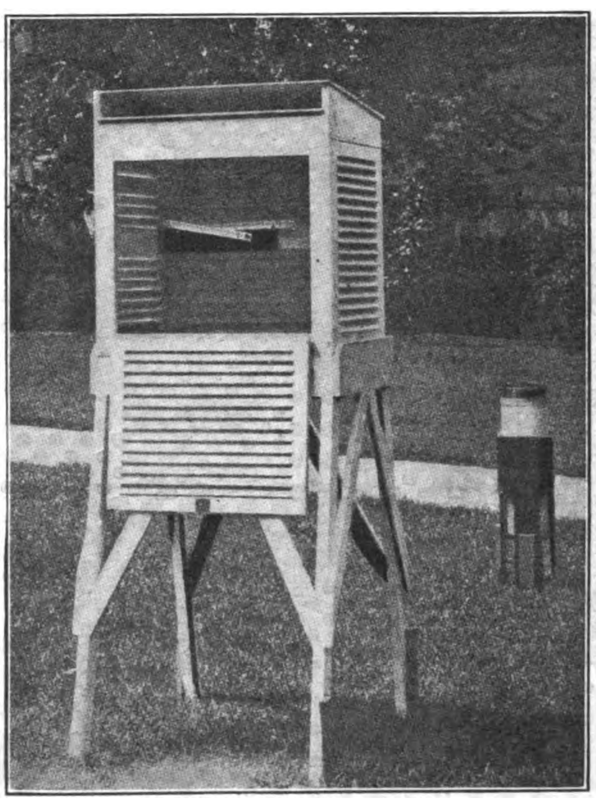
Variations in the pressure of the atmosphere are recorded by the barographs, highly accurate instruments placed in the office of the Weather Bureau. The automatic instruments are so arranged that they mechanically register in the Weather Bureau below the roof. The visual readings are taken twice in every twenty-four hours, at 8 o'clock in the morning and at 8 at night.

Temperature, pressure of air, precipitation, direction of wind, current, wind velocity, clouds and maximum and minimum temperatures are factors which go toward making up the day's weather report.

Measuring Temperature and Where to Place Thermometers

As specified in the publications giving instruction for official weather-observing conditions, thermometers in meteorological stations must, whenever possible, be placed in a perfectly open space where the circulation of air is entirely unobstructed. It will not do, however, to place the thermometers simply in the open air, exposed freely to the sky and to the direct rays of the sun. The sunshine would cause the thermometers to register too high, and even if not exposed directly to the sun, it could not be depended upon to register the true air temperature either day or night.

To overcome these difficulties, the Weather Bureau experts or those contemplating taking scientific weather observations, employ for the purpose a special *thermometer shelter* or housing, constructed in the fashion shown in one of the accompanying illustrations. This shelter comprises a box with slatted or louvered sides, constructed in such a manner that the air can move thru all sides with the greatest possible freedom. The object of this shelter is to screen off the direct and reflected sunshine and the radiation to and from the sky, as well as to keep the thermometers dry.



Approved Style of Housing, Provided With Venetian Blinds, for Supporting the Maximum and Minimum Official Thermometers. The Instrument in the Background Is a Standard Type Rain Gage.

The thermometer shelter should be placed in the open air on a house top where the circulation of air is as free as possible. When it cannot be placed on the top of the building it may be placed on the north side of the building. The building itself should be free from vibration so as not to interfere with the readings of the thermometer.

In one of the accompanying photographs, a rain gage of a simple type is shown just behind the thermometer shelter. In actual practise, the rain gage should be placed at least fifteen to twenty feet away from the shelter and in the open. In all cases, the position of the thermometer house must be such that the door opens to the *north*. Maximum and minimum thermometers are generally placed in the shelter.

The highest and lowest temperatures since the preceding readings are taken by *maximum* and *minimum* thermometers exposed in shuttered shelters on the roof. One curious fact which the weather man points out is that a person rarely feels as hot as the day really is. Usually there is between 10 and 15 degrees difference in the actual and sensible, or human body's temperature. Only in time of heavy fog or storm is it the same.

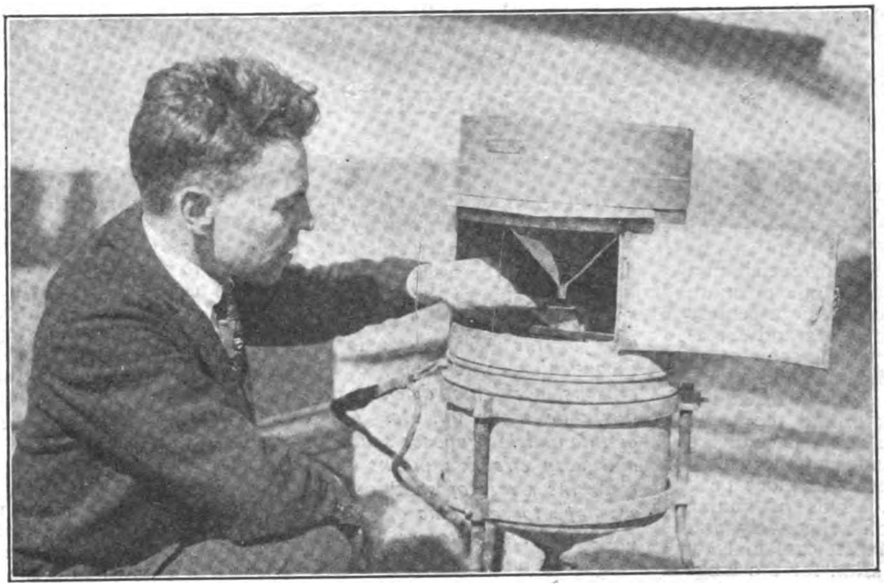
To measure wind velocity, a rotating windmill-like instrument called the *anemometer* is spun by the wind—the higher the wind velocity, the faster the instrument spins. This self-registers so as to make a continuous automatic record of the wind, showing the rate and time of occurrence of all winds. A *thermograph* writes the temperatures unceasingly by clock time, and the moisture is measured by the hygrograph.

Perhaps the most important piece of scientific machinery in Uncle Sam's weather bureau outfit is the meteorograph or triple register. Three things are recorded on this scientific invention, the direction and velocity of the wind, the rain and sunshine.

Recording Sunshine

Sunshine is the last element which enters into the weather report. It may be noted by the naked eye, but for fear the weather man might err, a *sunshine recorder* has been devised. The sunshine recorder comprises a glass bulb partly filled with mercury and exposed to the sun in such a manner that the light rays are registered by the electrical wires which extend from the sunshine recorder on the roof to the meteorograph or triple register in the office below.

Therefore the weather prophet reads his various barometers, thermometers, hygrometers and anemometers and takes the figures from them all. These he uses in his semi-daily computations, and by comparing them, by noting just what the wind, rain and sunshine have been doing for the last 12 hours, he can forecast the weather for his vicinity for the next 12 hours, even for a longer period, once he has received the telegraphic reports from other communities of weather conditions.



This Tipping Bucket Rain Gage—as the Delicately Balanced Bucket Shown at the End of the Operator's Finger Periodically Fills and Empties, Causes a Record to be Made on a Recording Drum. The Bucket Tips in One Direction or the Other, When Filled With a Quantity of Water Representing .01 Inch of Rainfall.

Details of the Simplest "Rain Gage"

The standard rain gage of the simplest form consists of the following parts: the receiver A; the overflow attachment B and the measuring tube C. The top cylindrical portion of the receiver, marked *a* in the figure, is exactly 8 inches in diameter, inside, and is provided with a funnel-shaped bottom, which conducts all the rain caught in the receiver into the tall, cylindrical measuring tube C, the total height of which, inside, is exactly 20 inches. The diameter of this tube is much smaller than the large receiving tube *a*, being only 2.53 inches. In consequence of this a small amount of rain falling into the receiver and flowing into C, fills the latter to a depth *greater* than the actual rainfall, in proportion as the area of the receiver is greater than the area of the measuring tube. In the standard gages of the U. S. Weather Bureau, the depth of the rainfall, in accordance with this principle, is *magnified just* 10 (*ten*) *times*. The receiver A has a sleeve, *d* (see figure) which slips over the tube, C, and very effectually prevents any loss of rainfall. Again, when the rainfall is very heavy the tube C may overflow. In this case, to prevent loss, an opening, shown at *e*, (see below) is made in the sleeve *d* just on a level with the top of the tube C. The excess of rainfall escapes thru this opening, and is retained in the large overflow attachment, B, and can be measured afterward, as will be described later. The opening *e* is omitted in the latest forms of gages, as the water easily flows between the sleeve and the tube C, which fit each other loosely. The inside diameter of the overflow attachment is just 8 inches, and this portion of the instrument can be used as a snow gage, as will be explained hereafter.

How Rainfall and Snowfall Are Measured

Rudyard Kipling in his story of the flooded mine, called "At Twenty-Two," states that an inch of water on an acre of ground weighs one hundred tons. This, like most of Kipling's technical points in his stories, is substantially correct, giving a character of accuracy to his imaginative topic.

Rainfall.—The *measuring stick* of the rain gage is graduated into *inches* and *tenths* of inches. Remembering that the actual depth of the rainfall is *magnified ten times*, as explained above, it is plain that if we find the water 10 inches deep in the measuring tube, then the actual rainfall must have been only 1 *inch;* or if the water in the tube is only one-tenth inch (or written as a decimal, 0.1 inch), then the rainfall must have been only one-hundredth inch (or written as a decimal, 0.01 inch).

The depth of the water is measured by inserting the measuring stick into the gage thru the small hole in the funnel. When the stick reaches the bottom of the measuring tube, it should be held there for one or two seconds, and then quickly withdrawn and examined to see at what division of the graduation the top of the wet portion comes. The numbering of this division, as stamped on the stick, gives, as has just been explained, the actual depth of rainfall, and in making out records and reports observers always use the decimal expressions.

After measuring and recording in this way the precipitation found in the gage, the top should be removed, the measuring tube should be emptied and drained, and the gage put in position again.

Snowfall.—During the winter season, especially in those climates where the precipitation is nearly all in the form of snow, the overflow attachment only of the rain gage should be exposed in the support as a *snow gage.* The receiver and measuring tube are taken out, as these parts cannot be used for measuring snow, and even if rain should occur it is very apt to be frozen while in the measuring tube, generally bursting it and rendering it worthless or highly inaccurate.

The first method for measuring snow is as follows: The snowfall collected in the overflow attachment is measured after placing the vessel in a warm room until the snow is *melted. The water is then carefully poured into the measuring tube, and measured just as tho it were rainfall.*

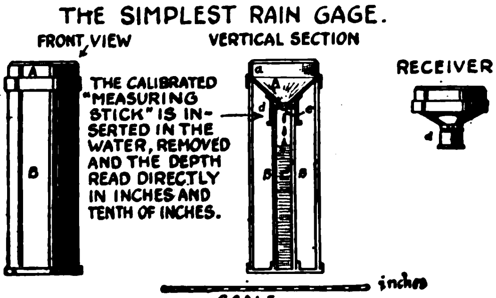
The Tipping Bucket Rain Gage, with Automatic Recorder

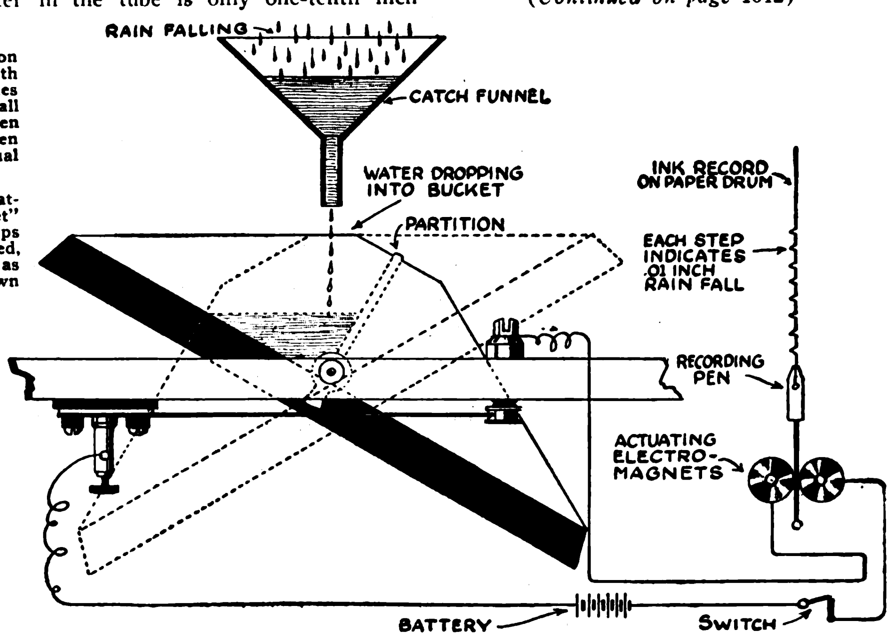
The top section of this gage, called the receiver or collector, is made of a sharp-edged brass rim, 12 inches in diameter, inside, and provided with a funnel-shaped

(*Continued on page* 1012)

The Simplest Rain Gage is Shown in the Illustration Below. A Measuring Stick is Used in Connection With This Rain Gage, the Stick Being Divided Into Inches and Tenth Inches. The Actual Depth of the Rainfall Gathered in the Cylindrical Tank C is Magnified Ten Times. Thus, if We Find the Water Standing Ten Inches Deep in the Measuring Tube C, the Actual Rainfall is Then Only One Inch.

The Large Illustration at the Right Shows the Operating Features and Principles of the "Tipping Bucket" Self-recording Rain Gage. Each Time the Bucket Tips Back and Forth, It Causes a Contact to be Actuated, Giving a Closure of the Circuit in Each Position so as to Make a Record on the Recording Drum as Shown at the Extreme Right.





Snow and Ice Melters

By H. GERNSBACK

WE know that every year our cities lying in the northern latitudes will be covered with snow and ice as regularly as clock work. For every "open" winter there are at least nine that are far from "open," and every once in a while when one or more good-sized blizzards visit our large centers traffic comes to a halt for days and sometimes for weeks. Shoveling the snow away—an archaic and antiquated method—helps but little. This was shown again forcefully last year in New York, where the snow could not be removed fast enough, and the puny efforts that were made only served to pack the snow down more and more until it finally turned to ice. This of course stopt all street railway traffic effectively, and as a matter of fact the street cars in New York were out of commission for the longest term in the history of the city, for they did not run in some instances for two months. This condition was created mostly by snow turning into ice and packing down on the level of the street for several inches, burying the rails entirely. Whatever traffic there was jogged along at a snail's pace because the unevenness of the packed ice made it dangerous for any vehicle to go at a fast pace.

This year the city administration will try military tank snow removers, but it is not quite clear how these will remove ice once it is packed down. They probably will remove snow if they start in immediately while the snow is still falling, and providing there are enough tanks in use to keep the streets open. If not, the tanks will fail just as ignominiously as did the street cleaners with their ridiculous shovels.

What we need is simply an imitation of nature. In the end the streets are always cleared well by nature due to thaw and warm weather. It is the only effective method of clearing away snow and ice, and if we cannot, have a natural thaw, we can at least have it an artificial one.

The writer proposes several methods, all of which have been tried in an experimental way, if not under actual conditions. There is no reason why any of these ideas cannot be used, not only by our traction companies, but by any city government which wishes to clear the streets of snow and ice, even tho there are no street cars on the streets in question; in this instance the apparatus would of course have to be mounted on some sort of vehicle, and not all the methods shown in our illustrations could be used.

One of the most effective means to clear not only snow but the more difficult ice is depicted in Fig. 1. Probably the hottest source of heat we have at our disposal and which can be used economically on any street car is the electric arc. Our illustration, as well as our front cover, shows how it can be used to dig any street car line out of its difficulties no matter how thick the ice.

On the front of the car as shown is rigged a sort of fender which carries a number of arc lights all pointing downward. They reach within one or two inches from the ground. The arcs between the rails are of the two-carbon variety, and the arcs are struck between the carbons themselves. There is enough heat generated near these arcs to melt anything for a distance of several inches.

In the back and staggered to the first row we find several more arcs which are to complete the work that the first row did not finish.

LAST year several of our eastern cities were visited by blizzards of extraordinary violence. Traffic was stopt for weeks at a time, and the cities suffered damages that have been computed to run up to $60,000,000 for the period, not to mention inconveniences to every one of the citizens, accidents, delays that could never be made up, etc. The writer of this article proposes several simple and very effective means to quickly clear the street of snow and ice, and we hope to see some of the methods tried out with success this year.

An interesting idea devised by the writer is that several of the arcs directly over the rails have only one large carbon electrode, and *the arc here is struck between the carbon electrode and the street rail.* No matter how much ice is packed on the rail, the electric arc will melt it like butter in no time.

It will occur at once to the reader that this would immediately melt the rail itself due to the tremendous heat of the arc. This would be true if the street car were standing stationary all of the time. But this is not the case. The car moves, even if it only moves at the rate of a few inches a minute—it still moves. Besides, as experiments of the writer have shown, as long as the rails have been covered with snow and ice, it is quite impossible to melt the steel underneath. *The ice and the resulting water must first clear away before the steel rail can be damaged to the slightest degree.* Any experimenter can readily convince himself of this. If by reason of the street being blocked the car should have to stop after the snow and ice had actually been melted, the motorman naturally would turn off the arcs until the car was ready to move on again.

In New York and Washington, where the third rail is underground, additional trouble is created by the slot thru which the trolley passes. The slot then becomes clogged as well and freezes up at times. This happened last year. By the method outlined above the melted hot water flowing down into the slot will clear the latter from snow and ice.

Another system is shown in illustration No. 2 where live steam is brought to play upon the packed snow and ice, the steam being generated electrically by heating the water while passing the current thru it. The current of course is furnished by the trolley car itself from the overhead wire. Live steam then issues from the steam nozzles in front, and by running the car along very slowly, either back or forward, or forward only, good progress can be made, and the line can be thawed out in a few hours.

Another method is shown in Fig. 3, where a hot air blast is used. The car is provided with powerful electric heaters; the hot air is then drawn over these heaters by means of air blowers. The hot blast in this way will act the same as the steam melters shown under Fig. 2. This hot air method, however, we do not think is as good as either the methods shown in Fig. 1 or Fig. 2, because hot air does not give the same degree of effectiveness as steam.

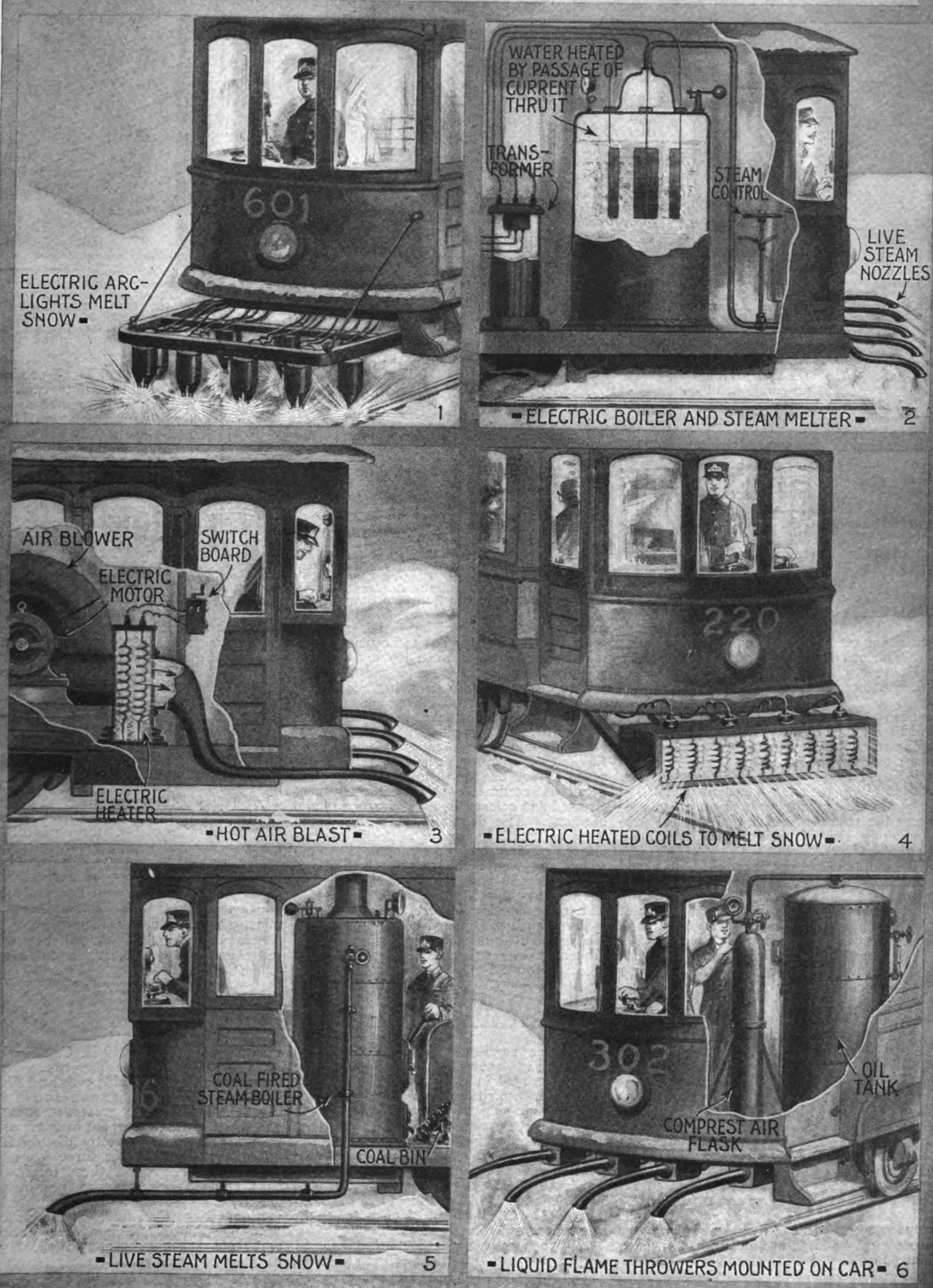
In Fig. 4 is shown another melter whereby a cage is equipt with powerful electric heaters, and which may melt a thin coating of snow and ice, but would never be effective in case there was a foot of snow on the ground.

In Fig. 5 we see an apparatus whereby live steam is generated by means of an ordinary coal-fired boiler, similar in results to the electrical method shown in Fig. 2. For quick and effective work perhaps this method would be preferable to the use of the electrically heated boiler; it is probably possible to generate steam quicker and better than by an electrically operated boiler. The method shown in Fig. 5 also has the additional advantage that it does not necessarily have to be used on a street car, but can be used on trucks, automobiles, etc., and on streets where there are no street cars.

We finally come to Fig. 6, where a street car is shown using an oil tank with comprest air to throw liquid flames on the rails. This method was tried out indeed last year in an experimental manner by using some army liquid flame throwers carried and operated by men. The results were certainly astonishing.

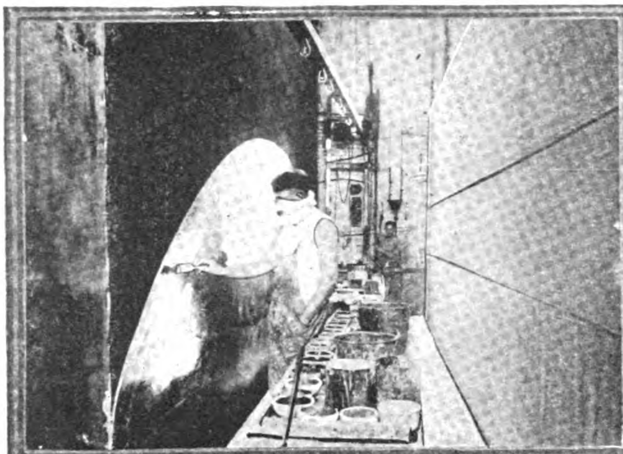
We predict that a few cars with a multiplicity of nozzles directed downward would certainly melt the thickest and toughest layer of snow and ice imaginable, and it certainly would be worth while to try any of the methods suggested. None of them are very expensive, and each of them may save our large cities millions of dollars.

SNOW AND ICE MELTERS

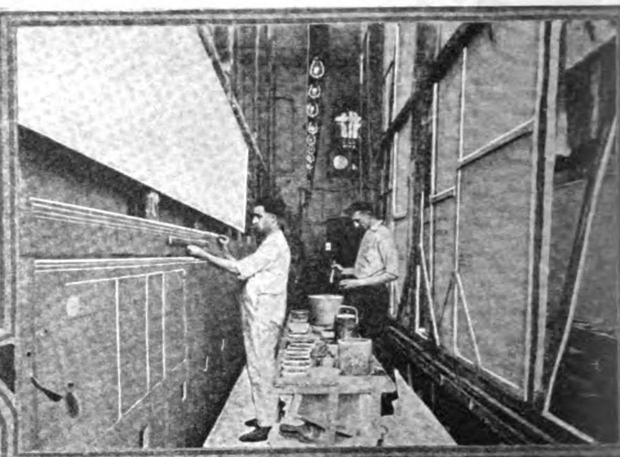


- ELECTRIC ARC-LIGHTS MELT SNOW - 1
- ELECTRIC BOILER AND STEAM MELTER - 2
- HOT AIR BLAST - 3
- ELECTRIC HEATED COILS TO MELT SNOW - 4
- LIVE STEAM MELTS SNOW - 5
- LIQUID FLAME THROWERS MOUNTED ON CAR - 6

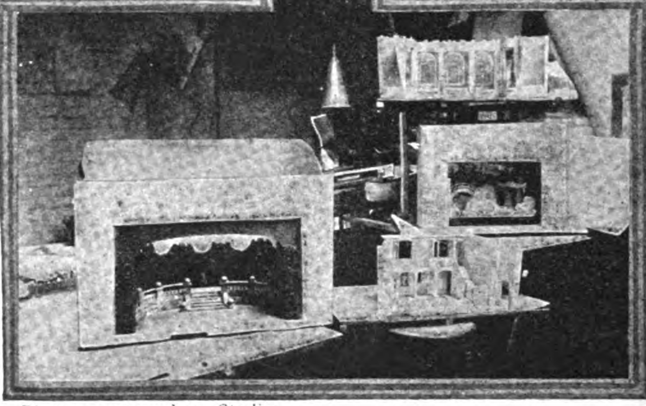
The Magic Art of Scene-Painting



Painting a Huge "Moon" on Canvas Back Drop From a Scene Painters' Bridge 40 Feet Above the Stage. The Various Bowls Containing Colors Are Seen on the Table in the Foreground.



Scene Painter Laying Out Perspective Lines on Back Drop Which Will Eventually Represent a Shoe Store. Real Shoe Boxes Will Be Placed in the Openings Seen in the Curtain.



Photos courtesy Law Studios.

This Shows How Stage Settings Are First Made in Miniature—Perfect Down to the Smallest Detail, Even to Vases, Clocks, Footstools, and Other Furniture. Colored Lights Are Thrown on the Miniature Settings to Obtain the Correct Data to Guide the Electrician in Lighting the Full Size Stage Production.

UNDOUBTEDLY, both the master mind and hand behind our greatest stage productions are those possest by the scene-painter,—several glimpses of a well-known New York scene-painter being shown in the accompanying views. One of the views shows a scene-painter preparing a "moon" scene, this moon being specially treated with metallic paint so as to make it luminous when lighted up in a special manner. It will be noted that the artist had to don a mask in order to avoid breathing in the fine metallic particles which float in the air while this particular scene is being painted, and which are injurious if inhaled in any great quantity.

Another photo shows several miniature stage settings; these act as the missing links, as it were, between the original scene as conceived by the artist or designer and the finisht full-size setting as finally painted for a theatrical production. If you have ever stopt to think about it, you have undoubtedly often wondered how the large scenes of buildings, streets, Venetian canals, *et cetera,* were actually painted so as to preserve the true perspective and relative proportion in size of each part with relation to the entire scene.

It would be almost impossible, it would seem, for the average artist to stand in front of a canvas as high as a stage-drop measuring, say, 40 feet by 30 feet, and paint a scene in its true perspective and always have it in correct proportion.

As in many other branches of the fine arts, science has been gradually lending more and more a helping hand, and the scenic artist of today has to be quite a fair mathematician, as he must lay out the perspective lines on the scene and also the full-size scene has to be accurately *scaled* off from the miniature stage setting or painting constructed like those shown in one of the photographs.

These miniature settings would surely fascinate any boy or girl, if he or she happened to see one of them, for every little detail is accurately and faultlessly constructed and colored in exact proportion and harmony. The details include such small items as vases, footstools, all kinds of furniture, window and door details in room scenes and even a clock on the mantel and pictures on the wall.

These model sets are frequently provided with colored celluloid screens or else with colored miniature lamps, so that the scene can be lighted up in the studio and the proper lighting schedules as to colors, etc., specified for the stage electrician to follow in the actual stage production.

The third photograph shows a scene being painted of the interior of a shoe store. The shoe boxes are mostly painted in the scene, but at periodic intervals a hole is left in the screen for an actual shoe box in order that the actor-salesman will be enabled to take out a shoe box so as to make the appearance and action of the scene very realistic.

As will be seen from the illustrations herewith, modern scene-painting represents, indeed, a great work, as it incorporates many branches of art and science which the average artist never encounters. The matter of properly mixing paints and gums to enable the rolling of big canvases is truly an art in itself, as any scene-painter will tell you.

Mr. and Mrs. Scene-Painter (yes, there are women who follow this work, too) must possess a first-class bodily equilibrium as most of the painting is done on the canvas while it is suspended above the stage, the scene-painter standing on a bridge about 40 feet above the stage floor. The canvas can be readily raised or lowered by pulling on a rope. Some of the painting is also done from ladders. There are no rails on the bridge, as will be seen, as this would interfere with the freedom of laying out the scene projection line with the scale sticks which measure 8 to 10 feet and even more in length. And here is where your bodily balance comes in. If you fall between the scene and the bridge, it's a 40-foot drop to the stage at least.

Micro-Organisms Seem Deathless

Most extraordinary living micro-organisms have been discovered in paper. These harmless entities possess remarkable resistance to heat and to time. They survive for hundreds, even thousands, of years, and then, under certain circumstances regain their activity. The Paris correspondent of the Journal of the American Medical Association writes of a communication on these organisms which Dr. Galippe presented recently before the French Academy of Sciences.

"However little one may know about the process of manufacture, it is not surprising that paper contains many micro-organisms," writes the correspondent, and continues: "But it was generally supposed that these were destroyed in the course of the many operations which are undergone in the stages from pulp to paper. Now, according to the researches of Galippe, this is not the case, and all papers in use harbor living and cultivable micro-organisms. What is more, these organisms offer considerable resistance to heat, since filter paper may be subjected for half an hour to a temperature of 120 C. in an autoclave without the least effect on them.

"Galippe was able to study a fragment of papyrus of the Ptolemaic epoch, that is, dating back to about 200 B. C. The structural elements of the papyrus were unchanged and the vegetable cells and fibers of which it was built up were found intact. The cells had not only preserved their form and reciprocal relations, but in some of them were found some perfectly distinguishable micro-organisms. After three hours' contact with sterile water these micro-organisms, immobile for centuries, regained their activity and showed themselves capable of motion. More than that, when placed in a favorable culture medium they multiplied and their development and different phases of their evolution could readily be studied.

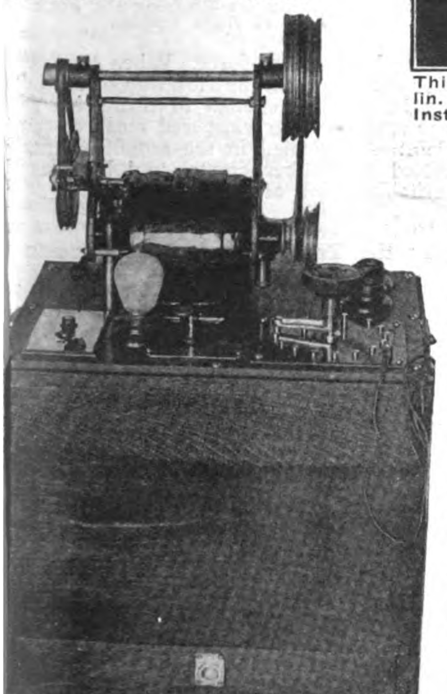
Everyday Science

)PERATING BY ELECTRICITY.

Specific drugs possess a like vibra-
ory rate as the diseases for which they
re effective.

These like vibratory rates (homo-
ibrations) of drugs owe their effi-
iency to their inherent radio activity.
'hus, an obsolete drug like *gamboge*
ainted on the chest in incipient tuber-
ulosis will effect a symptomatic cure
rithin a few weeks. Gamboge pos-
esses the same vibratory rate as tu-
erculosis. Our conception that drug
ction is dependent on direct cellular
ontact is thus demolished. One must
ecall that *wave motion is one of na-
ire's general methods for transform-
ig energy.*

All forms of energy whether derived
rom heat, electricity or magnetism
ay be made to yield different rates of
ibration, and these rates correspond-
ig to the diseases are utilized for their
estruction. It has been found em-
irically that the greater the poten-
ality (voltage) of the energy, the
iore effective are the results.



**'his Machine Nullifies Your Sense of Feel-
ıg, so That Physicians Can Operate With-
ut Administering Ether or Chloroform—
Thanks to Electricity!**

We have learned that energy may be
ilized to *increase* or *decrease* the ac-
ity of an organ and that with defi-
te vibratory rates of energy *one may
iplicate the action of a drug,* says
r. Albert Abrams, in a recent re-
irt on his newest invention, the
)scilloclast." No sensation of any
nd is perceived by the use of the
rrent from the oscilloclast, and it
absolutely innocuous. This is in
cided contrast to the accidents as-
ciated with Radiotherapy which
spite protecting devices make such
otection illusory. The action of
e oscilloclast is based on the fact
at every object has a certain natu-
l period of vibration and, if we ap-
oach an object with a source of vi-
ation of the same vibratory rate as
elf, the object will be set in vibra-
n.

)perations have been performed
inlessly by its aid.

This Is the Way They Cut Hair by Electricity in Berlin. We Presume the Kaiser Also Has One of These Installed in His Holland Castle, Altho He Got a Very Close Shave "a Short Time Ago."

HAIR CUTTING BY ELECTRICITY.

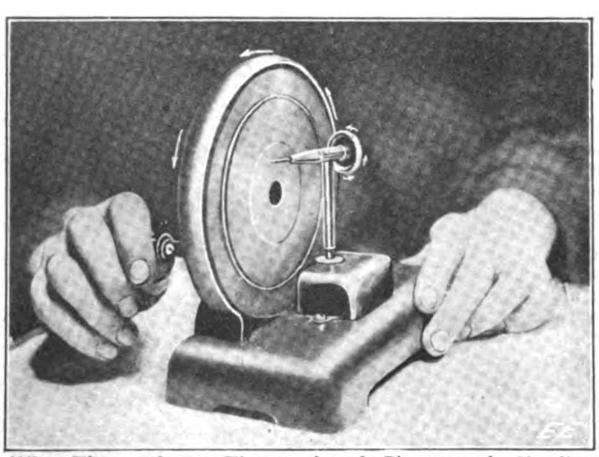
No, gentle reader, this is not as serious a matter as it looks, and this patron in a German tonsorial parlor is not having his hair removed by an electrocution process,—but instead by a very efficient motor-operated clipper, which removes it in lightning fashion.

This is said to be one of the latest Teutonic inventions.

NEEDLE REPOINTING MACHINE.

A needle is a small thing, but the world is made up of small things. A needle makes all of our clothes and, among other things, reproduces the music on our talking-machine records which are today so universally used that the waste of steel in these alone is quite considerable, as the requirements are so exacting and the pressure on the point so relatively great that even in the hardest of steel they are rendered useless after one playing over the 300 feet of the record groove.

With this clever little device a needle may be repointed many times. It is wonderfully simple, yet possesses some very interesting points.



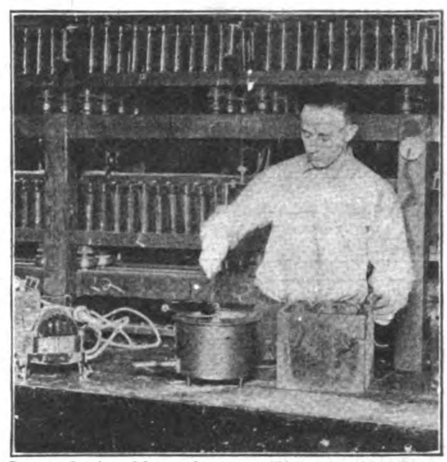
Why Throw Away Thousands of Phonograph Needles When, with the Machine Illustrated, They Can Be Sharpened in a Jiffy, Just as Good as New—Not Forgetting Sewing Needles.

NEW ELECTRIC "MELTING POT."

There has recently been developed an electrically heated compound melting pot for melting battery compound and other compositions of like nature which should interest garage and repair-shop owners, as well as all others whose business includes the manufacturing and repair of electric batteries. To such men the inconveniences and risks of the gas-flame method of melting compounds are the cause of considerable annoyance, due to the loss of time, waste of material and the increased fire risk.

The gas flame is a method of heating practicaly impossible to regulate with any degree of flexibility. It fails to give an even distribution of heat, and is unreliable. This, together with the haphazard sort of containers generally in use, necessitates the constant attention of the operator. If he is called away and forgets to turn down the flame the compound, owing to its inflammable nature, will soon catch fire, resulting oftentimes in considerable financial loss. Or, if the flame is turned down enough for safety, the compound will probably cool so as to necessitate its being remelted; hence, waste of time.

The new electric compound pot is made in four-quart size, and is solidly built with a bail to facilitate handling. It is provided with flange around the top, so



One of the Very Latest Electric Melting-Pot Devices, Suitable for Compounds, Wax Mixtures, Etc. It Is Shown Here in Use for Filling Storage Battery Tops.

that if it is desired, it can be lowered into a hole to bring the top flush with the table. This flange extends over the inside so that the compound cannot boil over the edge, this often being the case when old compound is desired to be remelted, inasmuch as old compound is often impregnated with acids. The inner flange also acts as a lip for scraping the compound from the ladle, thus preventing waste.

The heat is provided by a three-heat unit of the well-known cartridge type, which is inserted in a slot at the bottom of the pot. This unit is regulated by a three-point plug switch for obtaining three heats. The unit is reliable and does not require any attention of the operator. Many of these units are in use daily and are operating with entire satisfaction. *Photo courtesy General Electric Co.*

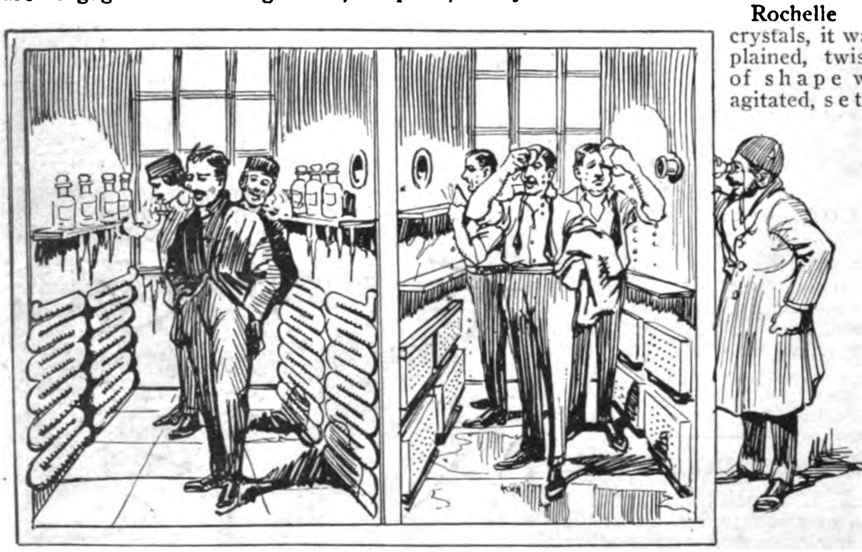
Electrical Marvels Startle Delegates

THE British, French, Italian, and Japanese delegates to the International Communications Conference left New York recently one morning for Washington to resume their preliminary session after a week's tour of American electrical industrial plants, which recently concluded with an inspection of the laboratories of the American Telephone and Telegraph and the Western Electric Companies.

When Dr. F. B. Jewett, chief engineer of the Western Electric Company, opened every secret door to them in his thirteen-story research laboratory at 463 West Street, where 3,500 engineers and employees are engaged in training volts, amperes, watts, and coulombs to do impossible things, they were overwhelmed with astonishment.

The Autograph of the Heart of Each Visitor Was Handed to Him After He Sat in the "Electrocardiograph" Chair—the Super-Sensitive String Galvanometer of This Instrument Registering the Delicate Heart Beat Currents on a Photographic Paper Strip. Modern Hospitals Employ This New Instrument of Science for Studying the Form of Heart Beat of Each Patient.

With the aid of Rochelle salts and a sound amplifier, the almost noiseless falling of the tumblers is magnified many times.



And Finally the Visitors Thought They Had Been Transported Suddenly to First the North Pole and Then to the Equator. Those Who Cared to, Were Allowed to Visit the "Hot" and "Cold" Rooms in Which Telephone Engineers Test Their Cables, Wires and Insulating Materials to Stand All Sorts of Rigorous Climatic Conditions. The Air Can Be Made as Damp as Desired in These "Bug" Rooms, as the Engineers Call Them.

Piezo-electricity

The first surprise was a demonstration with Rochelle salt crystals. "When it comes to gymnastics," explained the engineer in charge, "no one has anything on the Rochelle salt crystals." And every one agreed.

It was shown that when these crystals are twisted or pressed an electric current flows from them, is squeezed from them, as the engineer put it. And conversely, when a current flows into them they wiggle and wabble in a most capricious fashion. There was a phonograph with the ordinary reproducer replaced by a salt crystal. From this crystal wires were led to another crystal placed in a phonographic horn and when the phonograph was turned on the first crystal wriggled, producing currents which made the second crystal wiggle so violently that rich music poured from the horn.

Rochelle Salts Opens a Safe

How to open a safe without knowing the combination or wrecking the strong box was next demonstrated.

Rochelle salt crystals, it was explained, twist out of shape when agitated, setting up an electromotive force. When connected with the safe lock, the vibration of the falling tumblers is enough to throw the salt into spasms. The whispered moan of complaint is magnified in the amplifier, transmitted to another crystal and becomes a veritable shriek of agony.

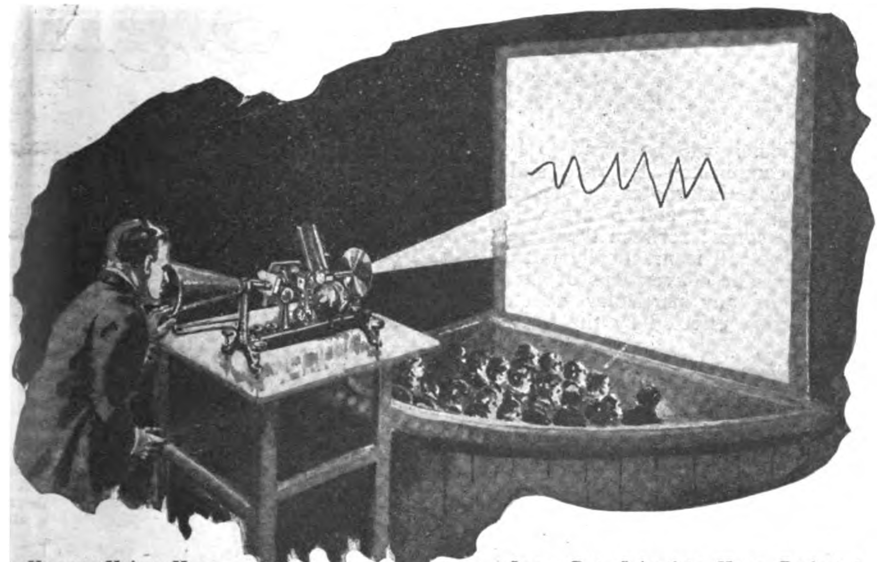
In the Tropical and Arctic Rooms

Then the visitors were led into the tropical room, where tropic conditions are reproduced for testing apparatus which is to be used in the equatorial regions. "Whew!" said Lieut. Gardiner of the British delegation, "everything here but mosquitoes and alligators."

And as they emerged in perspiration they were hurried into the arctic testing room where the temperature was far below zero and the only realistic touch lacking was icebergs and the midnight sun.

"Do you know," asked an engineer i

An Interesting Experiment Demonstrating Vividly the Presence of an Electric Current in the Body. By Plunging Both Hands into Two Metal Dishes Containing Salt Water, the Extremely Minute Electric Potential Present Was Indicated on a Sensitive Electric Measuring Instrument Known as a Micro-Voltmeter. A Micro-Ammeter Has Also Been Used for Indicating the Current.



ıe Human Voice Has ›en Rated at About 200 H. P. and Even Less, But Scientists Have Perfected an Instrument Known as the "Phonodeik" Which When Spoken into, Magnifies the ›ice Waves so That They Will Spread Across a Projection Screen Several Feet in Width as ›own in the Illustration Herewith. The "Phonodeik" Was Perfected by Professor Dayton C. Miller of Cleveland, Ohio, the Eminent American Authority on the Science of Sound.

other laboratory, "that every time your art beats one-thousandth of a volt is proced from your finger tips?"

They didn't. But when they dropt their gers into two shallow dishes of saltwater : pointer of a small instrument before :m flickered back and forth, registering :ir heart action. "Perhaps there's someng in this talk of magnetic personality d magnetic handclasp, after all," they d.

'elephone Talk from Ocean to Ocean

One of the demonstrations arranged was : setting up of communication by wires d wireless between the Catalina Islands the Pacific Ocean and a ship in the Atitic Ocean off the New Jersey Coast. The talina operator talked to the skipper of : Gloucester over 4,000 miles of telephone res and radio distances of about 100 les, while the guests listened in from a ing room in the Waldorf here where a nner was given for them recently by American Telephone and Telegraph mpany.

After the Catalina operator had told the pper of the Gloucester, who was riding ıeavy sea in the Atlantic Ocean's darkness of 11 o'clock, that the sun was just setting off California, Colonel John J. Carty, vice-president of the telephone company, cut in with:

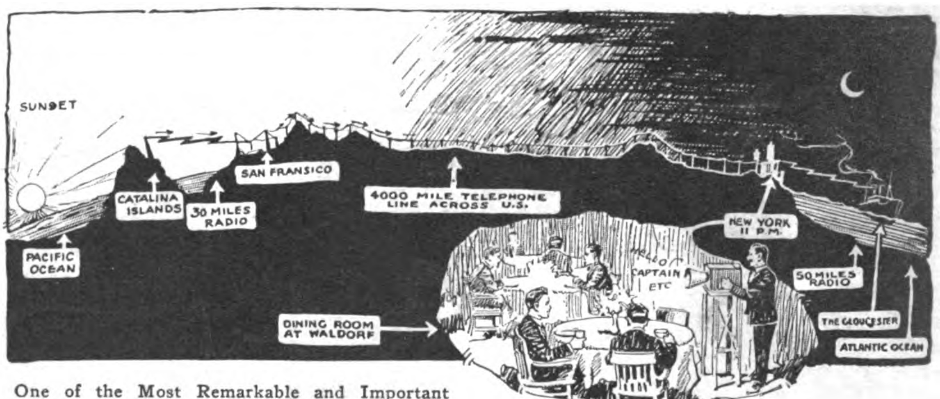
"You, Captain Nichols on the Gloucester, and Operator Spiker on the Catalina Islands, are taking part in an epochal event in wireless telephony. You are the first men to talk to each other from the Atlantic to the Pacific, across the waters of both oceans and the stretches of the continent."

The two men talked for about four minutes, and then Operator Spiker closed up his apparatus to go to supper and Captain Nichols to go to bed. Their conversation had been hampered somewhat by amateur operators, who insisted upon tuning up their radio apparatus to listen in both on the Atlantic and Pacific coasts. Static interference prevented the Gloucester from hearing well, but Catalina was able to hear every word with ease.

By automatic devices of American invention, the conversation was taken off the ends of the land wires and transmitted by radio to the ocean stations. The wireless distance on the Pacific was about thirty miles between wires' ends and the Catalina Island Station. The distance between the wires' end at New Brunswick, N. J., and the Gloucester was more than fifty miles.

Carrier-Current Phone Circuit

At 195 Broadway the visitors saw the demonstration of a carrier-current telephone circuit in operation from New York via Harrisburg to Chicago, a distance of 700 miles. This is not yet in commercial use, but will be shortly. Between Harrisburg and Chicago over each circuit of one wire twelve telegraph and one telephone messages could be sent simultaneously. In the demonstration five and a half telephone circuits and two duplex telegraph circuits were used without interference in conversations between the foreign visitors in the Broadway building and the company's representatives in the downtown district of Chicago.



One of the Most Remarkable and Important Experiments Conducted at the Laboratories of a Large American Electrical Company for the Benefit of Visiting Radio Experts Was the "Stunt" Illustrated Above. By a Special Arrangement on Overland Telephone and Radio Systems the Visitors While at Dinner in the Waldorf-Astoria Hotel, New York City, Had the Unusual Experience of Hearing a Radio Operator on the Catalina Islands Talk to the Mainland Via Radio, Thence Across the United States Via Telephone, and Finally by Radio Once More to the Steamship "Gloucester" in the Atlantic Ocean. It Was Sunset in San Francisco and 11 P. M. at Night on the Atlantic, When This Remarkable Combination Radio and Telephone Conversation Took Place.

› Would Ever Believe That ı a Simple Thing as Rochelle Could Help to Open a Com-tion Lock on a Safe Door? But ntists Have Found that When Rochelle Salt Is Crystallized, that the ıtals Will Pick up Sounds and Act Like a Microphone to Vary Electric ents in a Circuit and that Likewise, When Such Telephone Currents Are rest on Another Crystal It Will Actually Reproduce Speech or Sound.

What seemed to impress many of the delegates as the most interesting demonstration was one of cipher printing by telegraph. This has not yet gone into commercial use and has been one of the wartime secrets of the American Government and the American Telephone and Telegraph Company. Major Gen. Squiers, Chief of American Army Communications, and other military and naval officers present were not surprised at what took place because several months before the armistice this newly developed cipher printing telegraph system was in daily use between the War Department at Washington and its port of embarkation at Hoboken.

The cipher message was sent over a fifty-mile circuit from New York to Cliffwood, N. J., half of this route being by radio and the balance over return land wires. During the demonstration the delegates saw messages ciphered and then transmitted and

(*Continued on page* 1020)

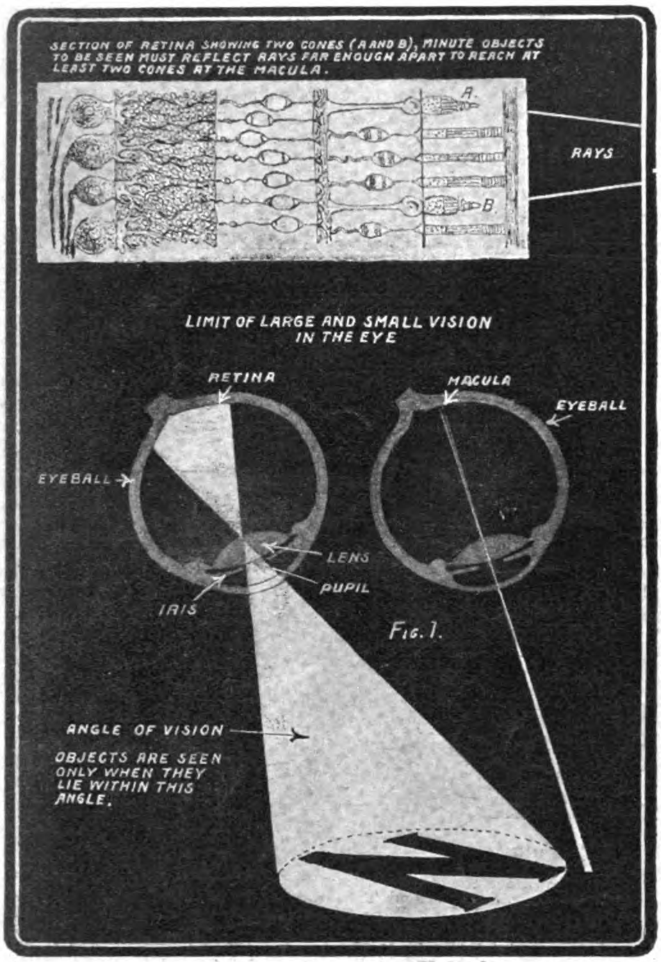
The Limitations of Sight

By WILLIAM M. BUTTERFIELD

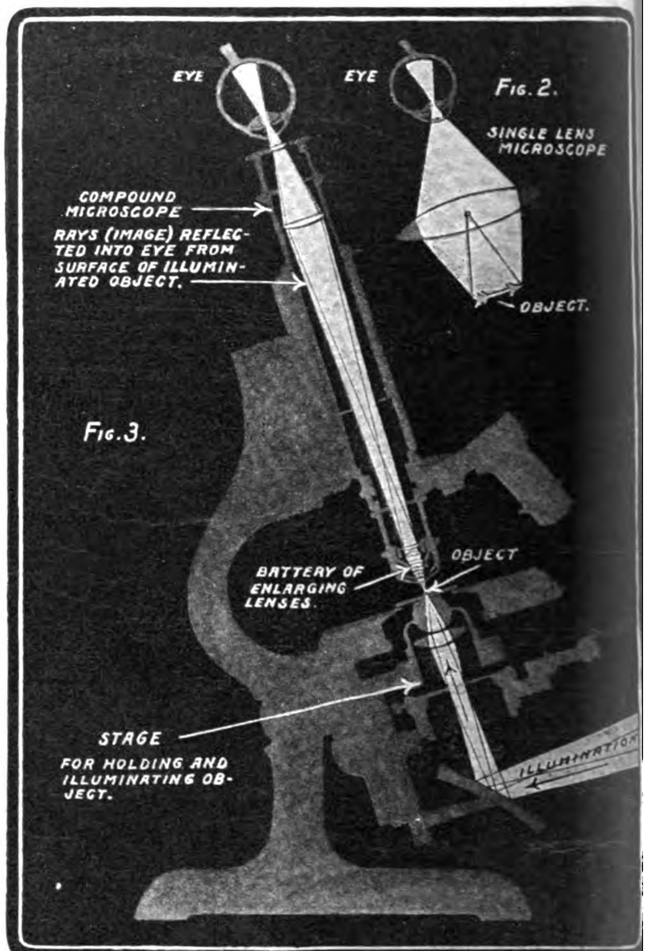
THE microscope and telescope have revealed many *invisible* living and inanimate objects, the microphotographic and telephotographic camera have given man a knowledge of still smaller or more difficult subjects than those shown by either one of the visual apparatus first mentioned, yet man is dissatisfied. He wants to see atoms, invisible stars and still other things of which he knows nothing as yet. Can he do it?

It now seems impossible that he will ever be able to see these lesser things, for two reasons. The first of course, is the nature of the limitations of the eye, and the next the insurmountable obstacles met with in the construction and use of artificial optical instruments, which after all is said and done, provide nothing more than optical assistance for the human eye with the adjunct, however, of the photographic plate.

Vision is limited in the eye by the qualities and action of a double convex lens whose faces change their radii of curvature or degrees of convexity under the action of adaptation muscles; next, by the iris with its sphincter muscle, that regulates the diameter of the opening of the pupil, constituting what the photographer calls his *diafram*—and finally by the size, shape and physiological qualities of the eye-ball with its retinal lining. If the eye is adequately studied, it will be found to be an exceedingly complicated structure, and the section of the retina shown in the cut, is a good example. *A* and *B* are what is known as the cones; between them are the rods. The eye-ball is practically unchanging in shape. The convex lens of the eye, independent of any particular effects of the diaframming effected by the iris, may accommodation reduces itself to the recep tion of parallel, or converging and diverg ing rays. As distant objects give virtuall parallel rays, it is merely a question of th sensitiveness of the retina, as defined by th size of the focal image falling upon it, tha limits the distance at which any specifi object can be seen. But where we come t objects so near that the rays from the



Schematic Diagram Showing the Passage of a Ray of Light Thru the Lens of the Eye, and Demonstrating the Angle of Vision. Rays of Light Impinge on the Retina at the Rear of the Eye-ball and Form an Inverted Image of the Object. The Detailed Diagram Shows the Layers of Cells at the Rear of the Eye-ball, and Note Particularly the Rod and Cone Layer, Which Is the Most Important Part of the Structure Dealing with Sight.



Comparison Between the Compound Microscope and the Single Le Microscope. Both Are Practically Identical and Have Substantiall the Same Effect Upon Vision, Except that in the Latter Only O Magnification Takes Place and the Rays of Light Do Not Cross. I Other Words, the Object Will Have to Be Upright in Order to B Viewed in that Position. In the Former, the Rays of Light Cross, D to a Battery of High-powered Lenses, and the Object Placed on th Stage Must Be Inverted in Order to View It in an Upright Positio

be taken as determining the angle of vision, as shown in Fig. 1.

The reflected, emitted or transmitted rays of light from an object pass into the eye by way of the convex lens, adapted to the distance by the action of the adaptation muscles and diaframmed for clear vision by the iris and produce upon the retina, the inverted focal image of the object. The angle of vision may be observed by closing one eye and noting how distant objects are affected and to what extremes, right and left and up and down the vision extends.

The iris opens in obscure light and closes in strong light, so that the reader can study or observe for himself what effect, if any, the change of opening of the iris has upon the field of vision.

These different movements which are very briefly and inadequately described, are known as accommodation and the accommodation system is in constant action, when the eye is in use on objects at various distances or is affected by varying light. The cease to be parallel, then it is a questio of adaption of lens and iris.

In normal eyes, an object appears to b a mere point when the rays of light fron it subtend an angle of 60 seconds. On th most sensitive part of the retina, th macula, the cones lie close together (.00 mm.) but in the outer part of the field o vision, the cones are farther apart, so tha vision there is less perfect. Approximatel back of the lens on the surface of the retin is a spot which is unaffected by light ray and is called the *punctum caecum*, quite th reverse of the *macula*, altho a near neighbo thereto.

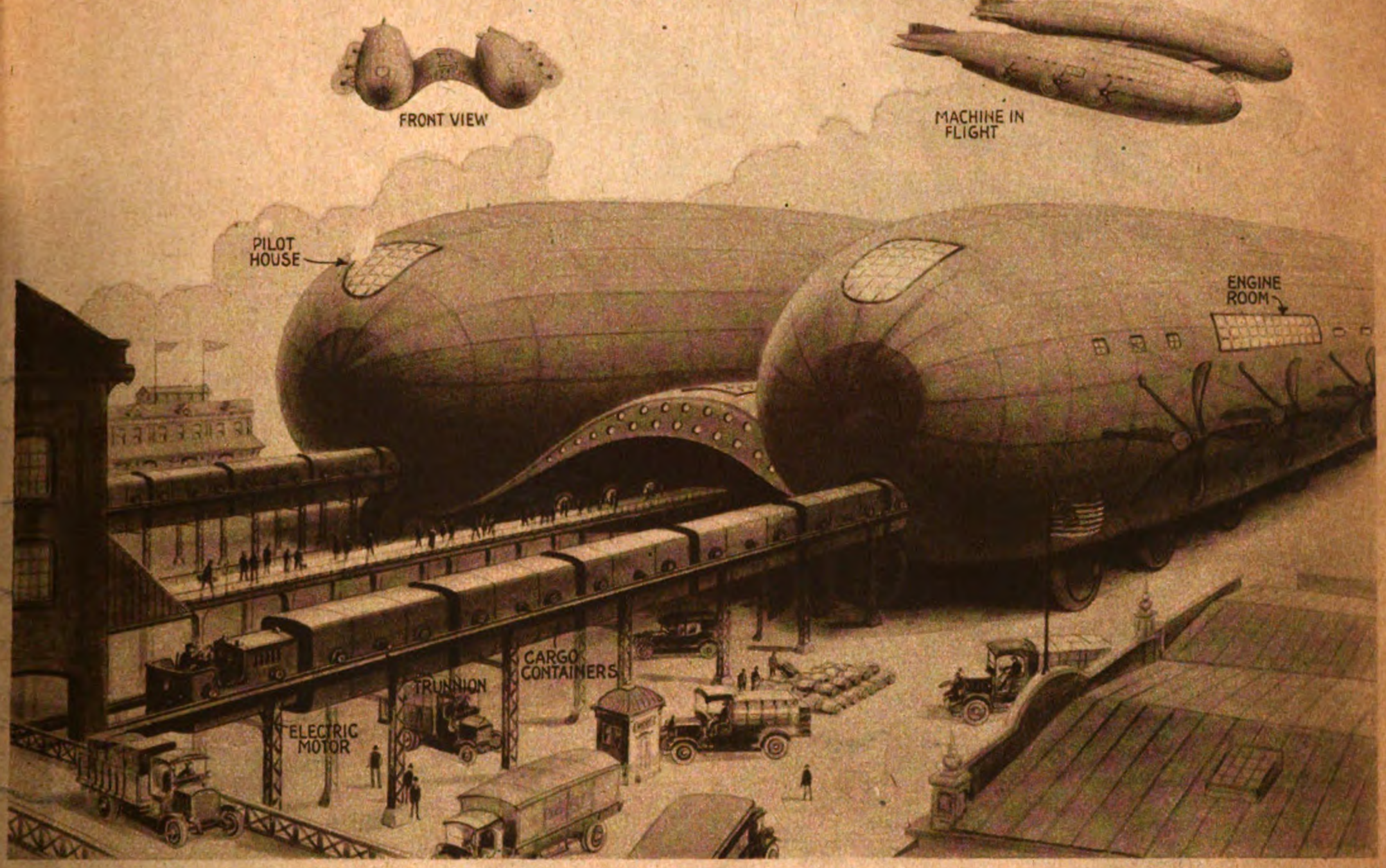
The microscope and telescope operate t increase the apparent size of objects. I the last resort, this resolves itself in causing the rays from the object to ent the eye at an advantageous angle, so as t cover a larger portion of the retina tha they otherwise would. This of course cu down the illumination and in the micro

(*Continued on page* 1006)

Freight Loader for Airships

By GEORGE WALL

(Illustration by the Author.)



When the Giant Airships of Tomorrow Arrive to Discharge and Take on Freight, Speed Will Be the Principal Desideratum. To Enable the Freight to Be Handled in the Shortest Time, So as to Keep the Ship in the Air, It Is Here Proposed to Pack the Freight in Metal Cars—These Cars Being Run in or Out with an Electric Locomotive as Shown.

AS commercial aircraft routes continue to develop, one of the promising and important features of this method of transportation is that of carrying freight and express shipments, aside from that of passengers. We know that a large number of passengers may be quickly taken on board an airplane or Zeppelin type airship, but it is another problem altogether, when we come to consider the loading of a number of these large airships with freight in the near future, when aircraft will be as common a sight as the ocean steamships of today. The writer of this article has given considerable thought to this phase of the subject, and illustrates herewith an idea which he believes quite feasible, not to mention necessary, in rapidly loading such giant freight-carrying aircraft, so as to keep them flying the greatest amount of time possible.

It requires several days to load some of the large ocean steamships at the present day, even with the highly developed loading and unloading machinery which has been installed at several of our large sea and lake ports. The scheme shown in the illustration will certainly serve to load one of these giant aerial Leviathans much more rapidly than is possible or has proven possible so far in the case of steamships.

The principal idea in this arrangement is to have the freight placed or packed into suitable steel carriers or cars, each one to contain a given number of tons of freight.

The freight can thus be gotten ready to load into the airship long before the actual shipping time, and when the ship arrives, her shipment of freight could be pulled out with electric locomotives, running along the rails as shown in the picture, and the return shipment stowed away in her cavernous maw, all within a few hours.

Incidentally, the writer shows in his illustration herewith a new idea in dirigible or lighter-than-air aircraft design, *viz.*, this type of airship comprising two individual gas bags joined together by a more or less shallow central compartment, which can be made of sufficient height to form a passenger-carrying compartment with staterooms, etc., for the accommodation of passengers.

It would seem a very good plan to provide two pilot rooms in the nose of each dirigible as shown, which had best be equipt with suitable controls, in duplicate, for steering and handling the giant aircraft, so that in the event that one set of controls should become defective, the other set could be immediately brought into play.

This type of duplex airship should operate very successfully in the air and should not prove any more difficult to handle than a single gas bag dirigible.

One of the reasons for suggesting this invention in the design of lighter-than-air machines, has been prompted by the belief in the fact that the maximum size of single gas bag machine has been about reached in the giant craft built by the British, such as the R-34, which made a successful trip across the Atlantic Ocean, and return.

To carry more freight than the R-34, for example, it would be necessary to build a longer ship, as the diameter could not, of course, be very much increased, for the length already adopted in the design of the R-34. Hence, the present suggestion that two such gas bags be combined and rigidly fastened together in the manner shown, resulting in a ship of moderate length and easier steering and handling qualities.

Several other ideas which the writer has had in mind for the freight-carrying airships of tomorrow, are the following:

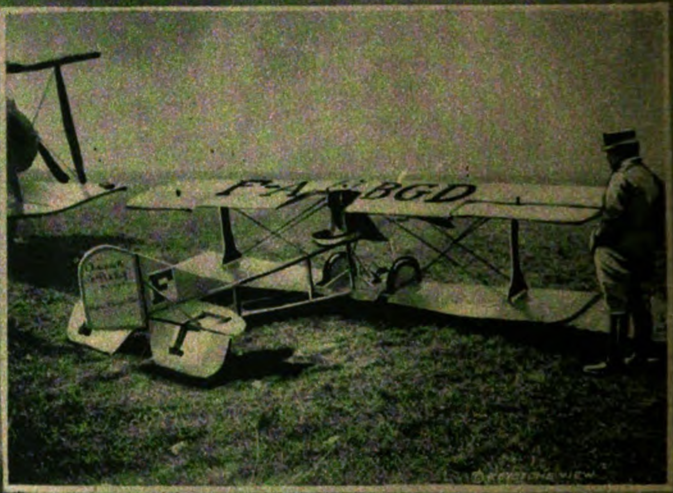
It has been found difficult to successfully repair gasoline engines used for driving the propellers of such aircraft when the engines are placed external to the gas envelope or cabins of the ship, and therefore it would certainly seem the best practice to place the driving motors inside the airship, grouping the engines as far as possible along a given axis so that the engineer crew could take care of the motors by passing from one engine room to the other quickly.

It is proposed to drive the propellers thru shafting and gears or they could of course be driven electrically by motors supplied with electrical energy from a central dynamo and gasoline engine plant, installed at a suitable location in the airship.

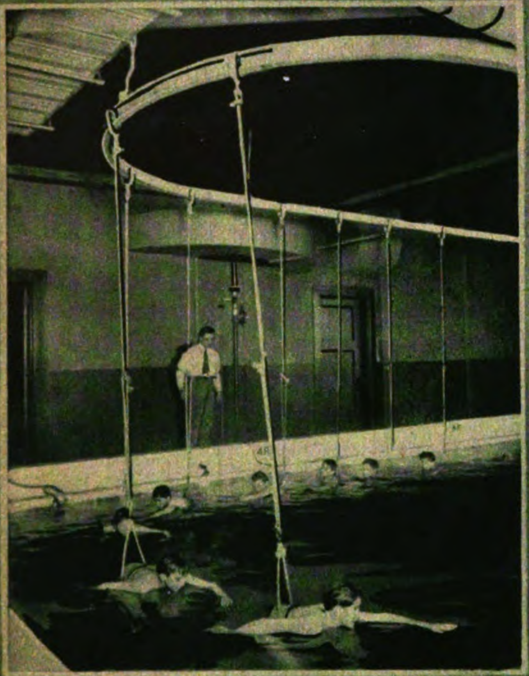
With this arrangement, the complete control of the airship is greatly improved and enables the centralization or focusing of all the engine power and other controls in the pilot's cabin.

The aircraft of tomorrow will duplicate, if not surpass, the large steamships of today in conveniences for the passengers Wireless telegraphy and telephony apparatus will be carried, as well as all of the usual appointments.

SCIENCE



The New Pishoff Aeroplane Photographed at the French Aviation Meet at Buc, France, Where It Attracted Much Attention. It Is Small and Known as an "Avionette." Note the Position of Pilot's Seat and the Wings. It Gets Its Name from the French Inventor, M. Pishoff. Compare With Man at Right.



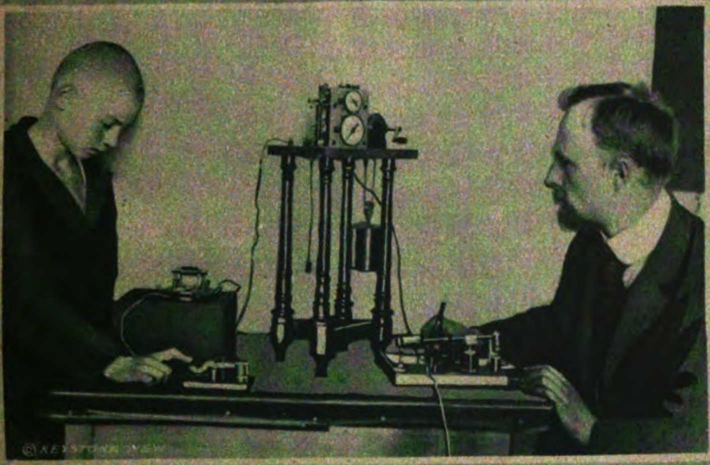
A "Water-Merry-Go-Round" Is Making the Task of Learning How to Swim a Pleasant One for About 6,000 Boys and Girls in Cincinnati. This Novel Invention Takes All Fear of Being Accidentally Submerged Out of Learning How to Swim and the Youngsters Give Their Undivided Attention to the Instructor, Easily Keeping Their Place in the Procession of Young Swimmers. An Oval Track Fastened to the Ceiling Above the Pool From Which Are Suspended Stout Ropes on Pulleys Running on the Track, Keep the Swimmers on the Surface of the Water.—Photo from J. R. Schmidt.

A Knotty Radish. No, There Is No Trick to This Radish. Just as You See It Is the Way It Came From Mother Earth. How It Came to Take This Turn in Life Is Unknown. Perhaps You Can Figure It Out. The Radish From Which the Photo Was Made Is in the Possession of Mr. S. G. Gill, of Wooster, Ohio, Who So Kindly Loaned It for Photographing. He Keeps It in Alcohol.
Photo from W. F. Mellot.

A Recent Photograph Taken of Thomas A. Edison, the Famous American Inventor, in His Laboratory at West Orange, N. J. Mr. Edison Spends a Great Part of His Time in One of His Several Laboratories Where He Works on Experiments in Electricity and Chemistry, in an Endeavor to Extract New Secrets from Dame Nature. Among His Great Contributions to the Welfare and Happiness of Mankind, Are the Phonograph, or Talking Machine, the Moving Picture, the Electric Light, Pioneer Development of the Electric Railway, Besides Developments in the Manufacture and Distribution of Cement, the Perfection of Nickel-Plated Moulds for Pouring Concrete Houses in One Operation—Including Stairs, Fireplace and Other Decorations, the Nickel-Iron Alkaline Storage Battery, an Instrument for Automatically Recording Telephone Calls in the Absence of the Subscriber, Etc.

No, This Is Not an Iceberg from the North Pole, but One Made by Man. More Than 20,000 Blocks of Ice Are in This Land Iceberg, Comprising Over 6,000,000 Pounds of Ice. This Sight, Never Seen Before, Is in Covington, Ky., near Cincinnati, Where an Ice Plant Was Wrecked by an Ammonia Gas Explosion. The Force of the Explosion Was So Great That It Blew Away the Walls of the Building and Left the Ice Within Exposed to the Elements.

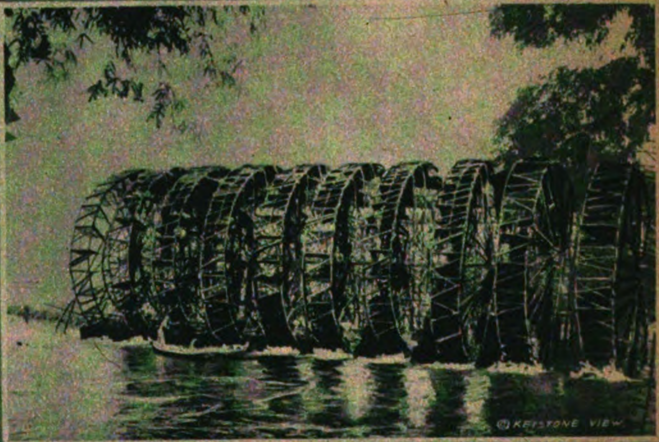
IN PHOTOS



Testing Boys to Find Their Qualifications Before They Are Apprenticed to a Trade Above:——Examining the Boy's Sense of Feeling. He Is Depressing a Morse Telegraph Key, at Regular Intervals, While the Little Watch at the Side Registers 1/1000 Seconds and Is Connected With the Key. It Indicates Whether the Same Amount of Exertion Has Been Used and How Evenly It Has Been Done. Below:—This Young Man Intends Being an Artist and Is Being Examined for His Ability to Test Colors.

New Automobile Direction Indicator. A New Device Which Is Attached to the Rear Left Fender or Body of the Car. The Diameter of the Face of the Indicator Is 10 Inches. The Four Signals "Right", "Left", "Stop" and "Back" Are Operated by Four Push Buttons Set in Switch Which May Be Attached to the Steering Post or Instrument Board. By Pressing the Button, the Correspondence Signal Is Brought Into View, and the Small Gong on the Face of the Indicator Rings in Order to Apprise the Other Automobiles and the Traffic Policeman of the Change in Indication. At Night the Signal Is Illuminated From Within.

One of New York's Marvelous Electric Signs. The Butterfly and Rose, Are All Shown in Their True-to-Nature Colors. The Various Groups of Lamps Are Winked On and Off Rapidly by an Automatic Motor-Driven Switch So as to Give the Effect of the Butterfly Flapping Its Wings as It Alights on the Flower.—Photo © Kadel & Herbert.



No, This Is Not a Giant Mouse Trap, but One of the World's Great Wonders—a Giant Water Wheel or Series of Water Wheels Joined to One Shaft and Constructed Entirely of Bamboo. Several Months Work and Thousands of Pieces of Bamboo and Rope Lashings Were Necessary in Constructing This Giant Prime Mover. The Water Wheel Was Photographed in Operation on the River Song, in Indo-China.

The Elixir of Life

By H. L. JOHNSTONE

FOR the tenth time in the last half hour, Billie Hoyt looked at the office clock. At last it was five o'clock. With a sigh of relief he tossed his pen at the rack, closed the heavy ledger, dashed into his street clothes, and rushed out of the office.

Billie, as a rule, was not a clock-watcher, as it is understood in a busy office. To-night, however, the clock had been dragging slower than ever before. There

. . . . . . The Tail Grew Out Slick and Shiny. In Her Excitement, Forgetting the Warning to Keep Quiet, Marie Gurgled Out: "Oh, the Cute Little Darling. Let Me Hold It, Father."

was a reason. He was going to take a run out into the quiet suburbs of Los Angeles to see Marie, the only daughter of Professor Straus, who spent most of his time dabbling in the mysteries of science. This was not the only reason, either, for Billie was going to ask the old Professor for Marie's hand. He did not think that there would be much objection raised on the Professor's part, for Billie had been a welcome friend for many months past. Neither did he figure that the question of money would cut much ice, for he knew that Professor Straus had been so busy during the declining years of his life trying to discover some wonderful elixir or other, that he had let his business run itself with the result that a thousand dollars or so were all that remained of a once good-sized fortune.

Billie spent a half-hour in tonsorial effort, and then, taking a hurried glance at the mirror, left his little room, and caught a trolley for Marie's.

It was only a half-hour's ride from the busy section of town and he soon found himself at the front door.

He pushed a button. The door opened, and Marie sprang to meet him.

"Oh, Billie! Won't Father be surprised when we break our secret to him?" she exclaimed as she gave him a bear-hug and a kiss."

"May be. Then, perhaps he will surprise me," replied Billie. "Let's go and see him right away."

"I think not. You would spoil every chance you ever did have if you bothered him now. He's working in that old stuffy laboratory and won't be bothered. I wish that he'd get done puttering and mussing all over the place with those nasty smelly chemicals. Come on in, and let's have some supper. I've tried to coax him up three times and the last time I went down stairs he pushed me out of the place and locked the door."

"Must have found something new, eh?"

"Guess so, from the way he acts lately."

Marie bustled around the little kitchen, putting the finishing touches to a savory meal, which she had spread out on a snowy white cloth. As she worked, she flashed Billie a glance from pretty brown eyes, that made him catch his breath.

The meal had started, and was progressing wonderfully for two young folks in love, when hurried steps were heard on the stairway leading from the laboratory. The kitchen door flew open and Professor Straus stood viewing the two.

He was excited.

"Hello, Billie. Just in time. Come on, you two, with me to the laboratory. I've found it at last!"

"Found what?" asked Marie. "I hope whatever you've found will give you time to eat your supper. Come on, Father, and eat now; or you'll be ill."

The Professor looked disappointed.

"The supper can go, child. Come on. Hurry up! This is too important a matter to wait! I've found it at last! *The Elixir of Life!*"

Half protesting at being disturbed, Billie and Marie bustled from the kitchen, down a flight of stairs and into the little smelly laboratory.

The Professor led them to a table, where lay upon a cushion, fast asleep, the worst-looking specimen of tom-cat Billie had ever beheld.

There was a rack of test tubes on the table with the cat, one of the tubes containing a dark green fluid. Picking out this particular tube, the Professor motioned Billie and Marie to chairs close to the table.

"Sit down, children, while I tell you what is in this tube. Marie knows that ever since the death of her dear mother, ten years ago, I have devoted my entire time to searching for the Elixir of Life. People have laughed at me, and said that I was crazy, still I kept everlastingly at it, and now I am rewarded. This little tube contains one ounce of the Elixir of Life. I am going to show you what it will do. See this cat asleep on the table? I judge him to be about ten years old. He is a hard-looking character and from his appearance has been in many battles. He is minus an ear and a part of his tail. Now I have found that each drop of this fluid turns the hands of time back just five years. It is given like medicine through the mouth. Whoever takes a drop finds himself just five years younger. Now I said that this cat is about ten years old. If I give him two drops, he will grow ten years younger."

"Impossible," blurted the impulsive Billie.

"Eh? How's that? Young man, what do you know about it? What do you mean by standing there and making such an asser-

(*Continued on page 1030*)

MYSTICAL MOVIES

In a New Vitagraph Serial, "Hidden Dangers,, in Which Joe Ryan and Jean Paige Co-Star. Many New and Startling Effects Are Obtained. Above We Find Joe Ryan Assisting in Cutting Open the Top of a Gas Reservoir with an Oxy-Acetylene Flame.

A Very Pretty Effect Is Produced by Allowing High Frequency Current to Pass Thru the Body to a Drinking Glass Held in the Hand; the Stream of Sparks Filling the Air-Gap Between a Dish of Water and the Glass.

Lighting Candles with a High Frequency Spark from the Finger. Joe Ryan Is Supposed to Have a Contraption Strapt Around His Body, Whereupon by Pressing Certain Buttons, Various Mystical Effects Are Produced.

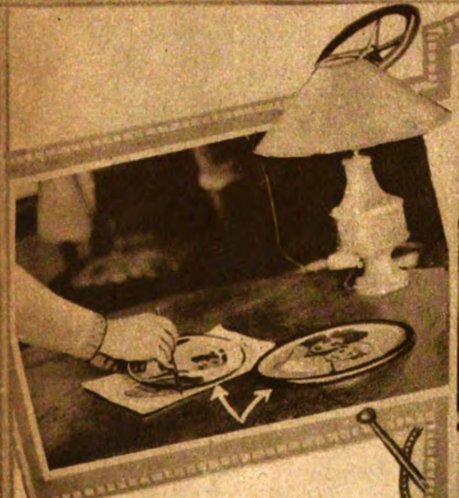
A Typical Portable High Frequency Apparatus for Producing Long Streamers of Sparks and Even This Is "Movified" for Effect, Rather Than for Actual Work.—Photo Courtesy Universal Films.

So Weird Is the "Hidden Dangers" Photoplay, That Even the Realms of the "Crystal Gazer" and the Masked Societies Are Encroached Upon. The Art of "Crystal Gazing" Is Pictured in This Strange Photoplay with Startling Reality and Effect on the Audience.

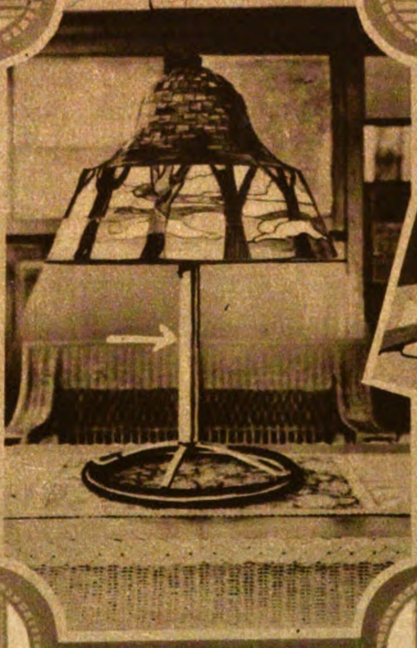
A Very Smple "Magic" Stunt Is that of Elevating the Body, or Levitation, as the Magicians Call It; but When Used in a Movie Thriller, It Produces a Far Different Effect Than When Demonstrated by the Professional Prestidigitator. The Magician Is Passing a Hoop Over the Body.

Volumes of Smoke Pouring from the Mouth of a Little Bottle Is Produced in Still Another of the Vitagraph Photoplays. Note the Spark Shooting to the Elbow of the Hindoo. The Smoke, of Course, Is Due to the Chemical Reaction of Two Substances in the Flask.

USING OLD "AUTO" PARTS



Why Not Use the Old Plain Glass Lens or Windows From the Head Lamps for Framing Pictures, After You Have Installed Those New Non-Glare Ones on Your Car? Circular Pictures Can Also Be Made Attractive With the Glass Discs From Discarded Head Lamps.



We'll Say This Is Some Novel as Well as Attractive Table Lamp. It Was Constructed With an Old Steering Wheel. The Wheel Itself Can be Either Re-Nickeled or Else Painted, and the Lamp Made Attractive With an Ornate Silk Shade.

And Who Said That Old Worn-Out Pistons Could Perform No Further Service After Being Discarded From the Engine? Here We See a Discarded Piston Acting as a Paper Weight, a Pen Holder, and Last, but Not Least, a Cigarette Holder.

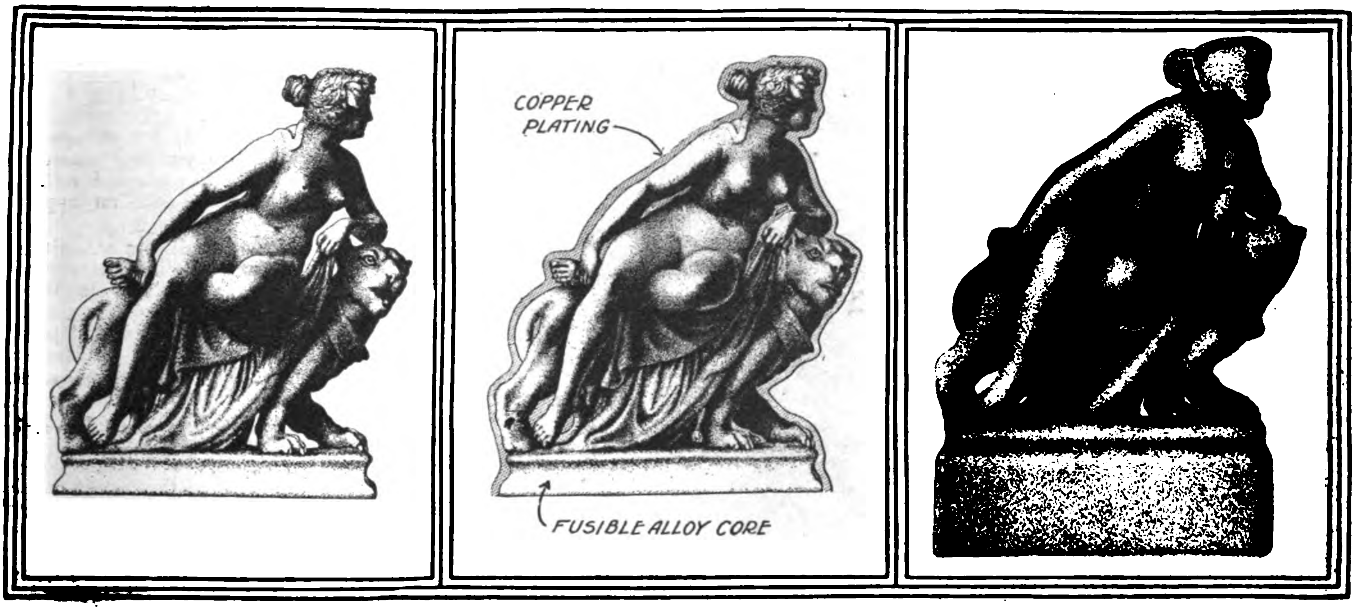
If You Have an Old Fireplace That Needs a Little Dressing Up, Here Is Where a Discarded Gear Shift Lever Comes in as a Poker; Real Colonial Looking, Is It Not? Many Other Uses for Discarded Auto Parts Will Readily Suggest Themselves.

As a Fireside Stool, the Old Tonneau Seat From a Discarded Automobile Can Hardly Be Excelled. It Is Exceedingly Comfortable and Can Be Placed in Any Odd Corner or Spot Desired. The Excellent Springs in Automobile Seats Provide Wonderful Comfort.

Speaking of Typewriter Lamps—What's the Matter With This One Constructed From an Old Speedometer Shaft? This Shaft Is Thoroly Flexible Permitting of Adjustment of the Lamp to Different Heights and Angles.

The Making of Copper Articles by Electrolysis

By SAMUEL WEIN



Various Stages in the Reproduction of Statues or Other Objects by the Method of Electrolysis or by the Deposition of Pure Metallic Copper on a Mold of the Object, Which Mold is Formed of a Special, Fusible Alloy Which Can Afterward be Melted Out. Any Thickness of Copper Deposit Desired Can be Easily Obtained.

THERE are a number of methods of manufactuing copper articles, but the electrolytic process is in many cases, the simplest and most inexpensive. Very little is known by the public concerning this process, inasmuch as the method is carefully guarded by those practising it; the reason for this being that the results are far superior in many cases to those given by processes in common use, and the profits realized in commodities made thus are surprisingly great.

In the electrolytic process, there are two distinct methods in use, and these are:

1. A mould is made of wax or similar naterial, and this in turn is rendered conluctive with either grafite, bronze powder or by precipitation of metallic salts, as by hemical reaction, and this is made the athode for the deposition of copper from ts sulfate or solution of some other salt.

2. A mould is made of a *fusible alloy*, nd this is electroplated as above and the lloy is removed by fusion or melting.

The first process is not so good as the econd, because the conducting surface of he grafite or other materials, at their best, re very poor, and great care must be xercised to give this a "flash" of copper nd a considerable time is needed to deposit his layer of copper. The wax mould is uite soft, and does not well withstand the reat pressure it is subjected to, in the rocess of electrolysis; therefore, the thickless of the deposited copper is limited.

The second process is more adaptable for commercial purposes, as the conductivity of the mould is greater and therefore much heavier deposits are possible in less time, than with the wax mould. Furthermore, finer details can be brought out better than by any other process.

Here are some of the commodities these concerns are actually making: automobile radiators and manifolds, head-light reflectors, seamless tubing, condensers for chemical purposes, phonographic tone-arms, honor rolls or tablets, etc. The number of commodities are legion, and would necessitate quite a long list, but the possibilities are obvious to many branches of manufacturing enterprises.

Method of Moulding.

A wooden pattern is made of the article in question and a matrix is made in plaster-of-Paris. After the plaster has "set" and is thoroly dried, a duplicate is made by pouring the alloy into or on (as the case may be) the plaster negative. After the metal is cold, the plaster negative is removed and the metallic core is prepared for the copper plating solution, this being done by steeping it in a solution of caustic soda for a few minutes, and washing in running water. A copper wire is attached to the metallic core at any convenient place, which is to serve as one of the conductors.

In some cases, the article is prest into the molten fusible alloy (which is poured into a shallow pan) and the alloy is suddenly cooled or chilled.

Fusible Alloys.

Many years ago, chemists discovered that by adding tin and bismuth to lead, the resultant melting point of the alloy would be very low and in fact some of these alloys are readily plastic in hot water. Here are several typical fusible alloys that have been found to give good results for the purposes covered in the present paper. Quite a large amount of these have been compiled and their general characteristics given in the Physico-Chemical Tables. Volume 1, page 394 to 397.

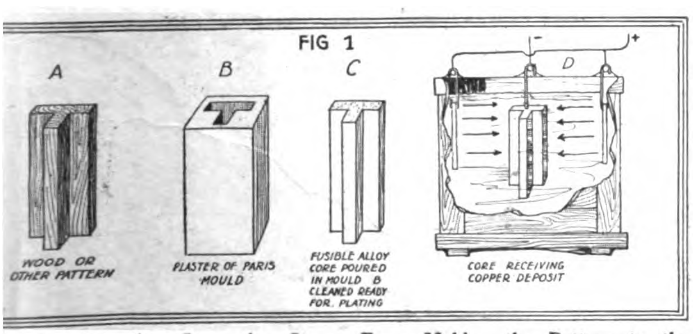
Lead	Tin	Bismuth	Mercury	Fusing Point. Degrees Fah.
2	3	5	..	212
5	3	8	..	183
2	2	5	1	158
5	3	5	2	127.5

The metals are melted in an iron pot in the usual manner, and about a pound of rosin is added to every hundred pounds of the alloy, this acting as a flux and keeping the alloy clean. The dross is then skimmed off with a ladle and it is ready for use.

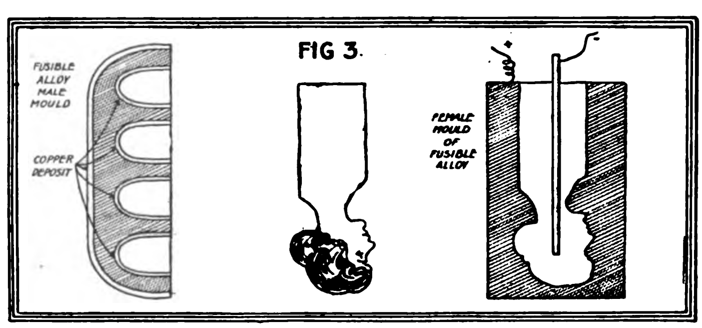
The Copper Plating Solution.

The composition of this solution usually consists of a five per cent up to a

(*Continued on page* 1008)



learly Showing Successive Stages From Making the Pattern to the Forming of the Copper Deposit on the Fusible Alloy Core.'



A' Left, an Automobile Engine Manifold, While the Center and Right Hand Views Show How a Two-Part Female Mold Is Plated from the Inside.

Popular Astronomy

By ISABEL M. LEWIS, M.A.

of U. S. Naval Observatory

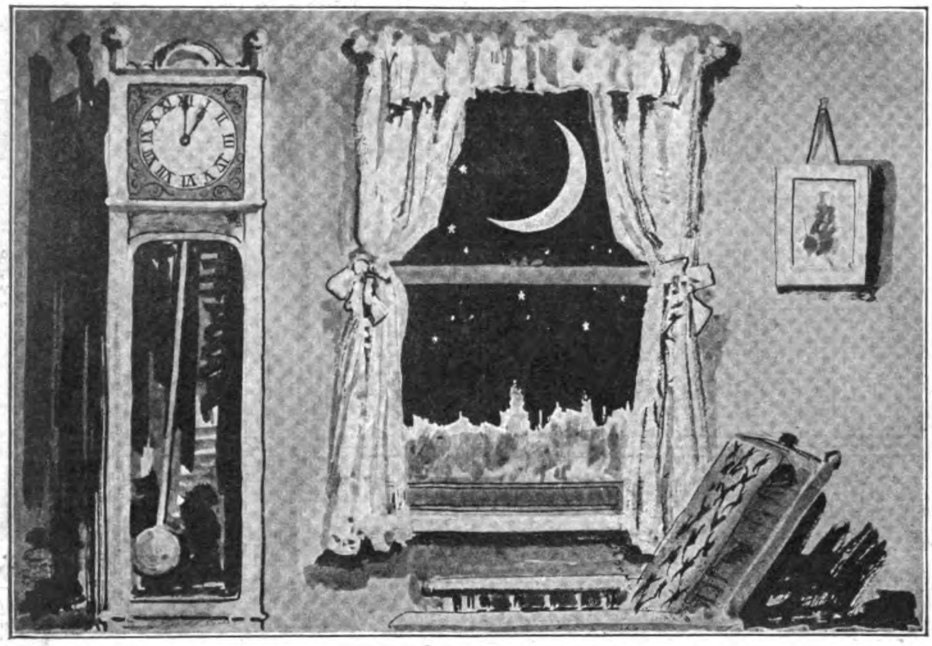
Keeping Track of the Moon

OF all celestial objects the nearest and most familiar and most troublesome is our satellite, the moon. It has probably caused the theoretical astronomer more work and worry than all the other members of the solar system combined, and he has still far from mastered the intricacies of the lunar motions, while the mistakes and blunders that an otherwise intelligent person makes when he ventures to refer to the various aspects and phases of the moon are quite unbelievable.

To be sure, nearly everyone knows that the moon is a solid body with no appreciable atmosphere, shining only by reflected light from the sun, and that its surface is rugged and mountainous and pitted with numberless "craters," also that it revolves around the earth in a month (approximately) keeping the same face always turned toward us, and that its various phases arise from the fact that we view the illuminated side from all different angles in the course of a month. Yet ask anyone of average intelligence when the moon rises before the sun and when after, or which limb, the eastern or western, is fully illuminated a day or so before or after full moon, knowledge that can be acquired by simple observations, or, again, why solar and lunar eclipses do not occur every month, and there are nine chances out of ten that he will not know. We all insist, tho, upon bringing the moon into poetry and fiction and we will continually depict in our drawings and paintings and our illustrated advertisements misunderstood and misrepresented moons.

It is well to bear in mind, if we are dealing with the moon, that there is but one place in the heavens where it can be found at a given time and that the lunar tables give that position whether it is in the year 2000 B. C. or the year 2000 A. D. or some year between these two dates, and it is exceedingly risky to venture to describe the appearance of the moon at some definite instant without first consulting an almanac.

If you want to talk freely and safely about the aspect of the moon on a given date look it up in the almanac first unless you can trust your memory. Do not be like the man who was sure he had seen the Southern Cross from New Jersey an yet could not get us interested in its allege appearance.



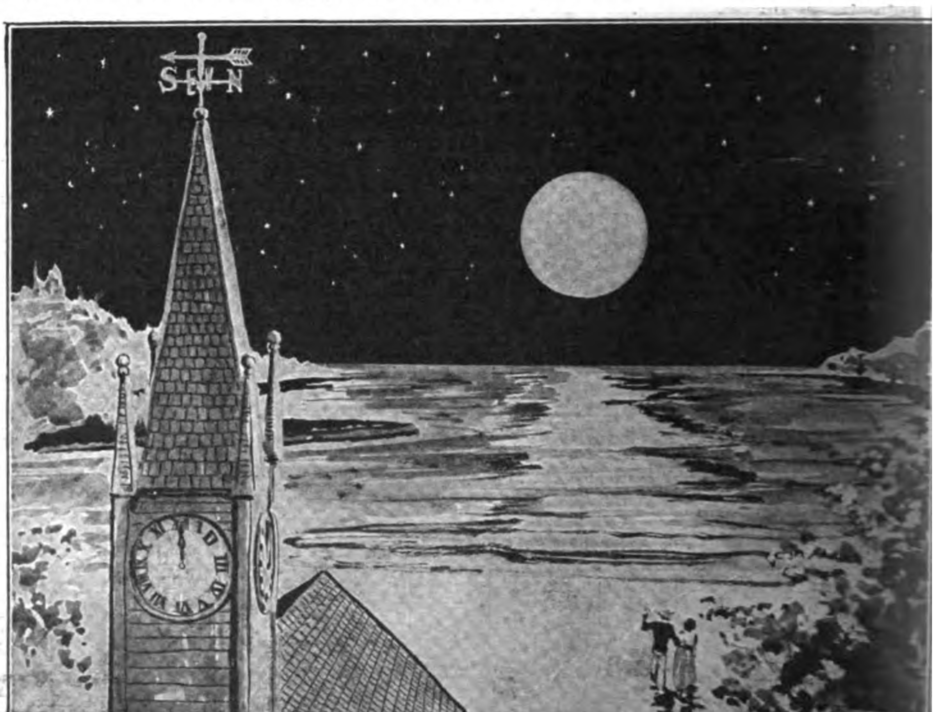
The Illustrations on This, as Well as on the Other Page, Show Some Impossible Moons. Often Artists Show Illustrations of Incorrect Moons of Which the Four Shown Here Are Good Examples. In This Illustration, We See a Crescent Moon at 1 A. M. High Above the Tree Tops. This Is Quite Impossible as a Crescent Moon Is Never So High Above the Horizon at This Time of the Night.

Who has not read in classics or in pop ular fiction of crescent moons riding hig in midnight skies, of full moons risin above western cliffs or setting beyon eastern lakes? Who has not seen the moo drawn in impossible positions with horn pointing the way they should *not,* or twinkling star shining thru an apparentl transparent moon?

Careful observation of the moon thru i various phases and at different seasons the best way to acquire a knowledge of th elementary fact regarding the motion o the moon thru the heavens from day to day but that requires one to be up often afte midnight and in the early hours precedin dawn and is probably one reason why w all feel so hazy as to what happens to th moon after it has passed the full.

A few fundamental rules can be easily acquired, however, and these will enable us to locate the moon in the right quarter of the heavens at any time of the day or night when we know its phase and the approximate position of the sun at the same instant, and thus we may avoid some of the most obvious blunders that are made in dealing with the general aspect of the moon at any given time.

As can be verified by direct observation the moon is always moving continually *eastward.* Since it makes a complete revolution around the earth from new moon back to new moon again in a little less than thirty days, it passes over about twelve degrees a day, (360° divided by 30) on the average, or one half a degree an hour which is the angular extent of its own diameter. Therefore every hour the moon moves eastward a distance equal to its own diameter. This is of course only *approximate* as the moon moves more rapidly in some parts of its orbit than in others. Observe the position of the moon with re-



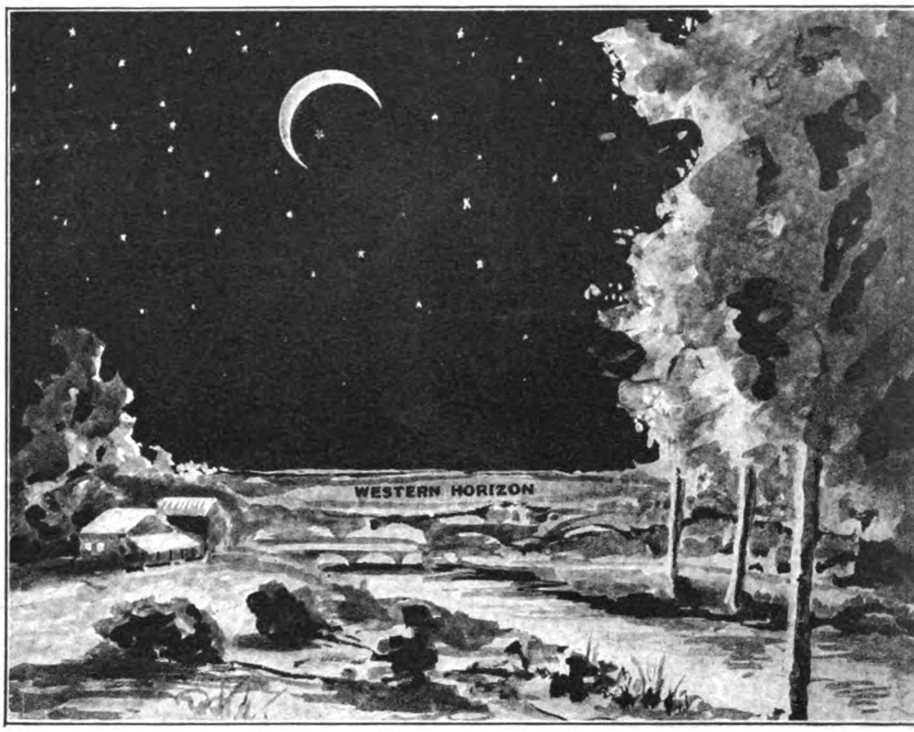
Another Impossible Moon. It is Impossible to Have Such a Scene as This with a Full Moon in This Position at Midnight. The Correct Moon Would Have to Be Very Much Higher up in the Firmament.

spect to a near-by "fixed" star, then observe it again after an interval of two or three hours to satisfy yourself that it really is moving continually eastward.

In addition to its *real* eastward motion the moon shares the *apparent* daily *westward* motion of all celestial objects which is due to the daily rotation of the earth on its axis in the opposite direction. That is, the moon, as well as the sun, stars and planets, rise in the east and set in the west daily. On account of its continuous eastward motion, however, the moon rises later every night, on the average about fifty minutes, tho the amount of this retardation of moon-rise varies from less than half an hour to considerably over an hour at different seasons of the year and at different latitudes. In the course of a month then the moon has *risen* at all hours of the day and night and *set* at all hours of the day and night.

It might seem unnecessary to emphasize the fact that the moon always rises in the east were it not that the astronomer occasionally meets with the man who insists that he has *at times* seen the moon rise in the west.

What he has in mind is the new crescent moon which first becomes visible above the western horizon shortly after sunset tho it rises in the *east* the morning of the same day shortly after sunrise. As is also true of the sun the exact point on the horizon where the moon rises or sets varies from day to day and from season to season. ***In one month the moon passes over very nearly the same path thru the heavens that the sun does in one year,*** for the moon's path is inclined only five degrees to the ecliptic or apparent path of the sun thru the heavens. It can never pass more than 28½° (23½°+5°) south of the celestial equator nor more than 28½° north of it. It has a slightly greater range in altitude than the sun, therefore. North of 28½° North Latitude it always crosses the meridian *south* of the zenith and below 28½° South Latitude it crosses the meridian *north* of the zenith. In tropical regions the moon sometimes passes north of the zenith, sometimes south, or again directly thru the zenith.



The Above Illustration Shows Three Glaring Mistakes.
1. It is Impossible to Have the Horns Directed Towards the Horizon. 2. A Star Cannot Appear in the Position Shown Because a Star Cannot Be Inside of the Dark Portion of the Moon. 3. The Horns Cannot Extend More Than 180 Degrees Along the Circumference.

Since the *full* moon is always diametrically opposite to the sun it traces out nearly the same path across the heavens that the sun traced six months before. In winter then when the sun is south of the equator the moon "rides high" at night north of the equator and, vice versa, in summer when the sun is north of the equator the full moon "rides low" south of the equator. In winter then we have more hours of moonlight than we have in summer. This may be of no great advantage in mid-latitudes but we can imagine what a boon it is in the Arctic and Antarctic regions to have the friendly moon above the horizon so continuously.

At time of "new" moon the moon lies directly between us and the sun but ordinarily passes just to the north or south of the sun since its orbit is inclined five degrees to the ecliptic. If the moon's path lay exactly in the ecliptic we would have an eclipse of the sun every month at new moon and an eclipse of the moon two weeks later at *full* moon. Now the moon crosses the ecliptic twice a month, the points of crossing being called the nodes of its orbit, but only twice a *year* is it nearly enough in line *with the sun* at the time it crosses to cause eclipses. Every year then there are two "eclipse seasons" separated by interval of six months when the moon is in line with the sun *at or close to the point where it crosses the ecliptic;* then and only then can solar and lunar eclipses occur. The solar eclipses of course, will occur when the moon is *new,* that is when the moon passes directly between the earth and the sun and throws its shadow over the earth; and the lunar eclipses two weeks later when the earth passes between the sun and moon and throws its shadow over and beyond the moon.

It is doubtful if there is any astronomical subject that has been more generally misunderstood than that of solar and lunar eclipses. It is well to remember that solar eclipses can *only* occur at time of *new* moon and lunar eclipses *only* at the time of *full* moon and at the time of eclipses, whether lunar or solar, the moon is at or near its nodes, the points where its orbit crosses the ecliptic. There are always at least two solar eclipses every year and there may be as many as five. There are years when there are no *lunar* eclipses, tho ordinarily both solar and lunar eclipses occur every year, some partial others total.

The moon shines only by reflected sun light. It is of itself a solid, dark body with its day surface intensely hot and its night surface intensely cold, a world of extreme temperatures.

At new moon *all* of the night side of the moon is turned toward us, at full moon *all* of the day side. At other phases we see part of the day side and part of the night side and *the illuminated side of the moon is always the side that is towards the sun.* Failure to observe this simple rule leads to many grievous blunders in depicting the moon.

At the time of new moon the moon, moving continually eastward, passes north or south of the sun *from west to east* except when it passes directly in front of the sun causing eclipses. A day or so later the waxing crescent moon or the "new moon," as it is popularly called, becomes visible low in the west immediately after sunset. The moon is now east of the sun and will remain east of the sun until the time of full moon. During the period from new

Still Another Impossible Moon. This Shows a Gibbous Moon, and It Is Impossible to Have It Thus on the Eastern Horizon. It Will Be Noted That the Wrong Limb Is Defective, and the Moon Is Below the Eastern Horizon at Sunset.

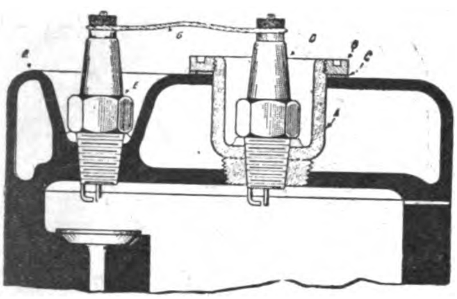
(*Continued on page* 1021)

MOTOR HINTS

ADDING A SPARK PLUG TO THE FORD

First Prize $25.00

It is a well known fact today with the poorer grades of fuel that cars are compelled to operate on, that the burning of the charge in the cylinder can be accelerated by the use of greater ignition, or in other



This Diagram Shows the Mechanical Steps Necessary in Fitting in Extra Spark Plugs in the Ford or Other Automobile Engine. A Special Cast Iron or Mild Steel Bushing Is Made and Threaded into the Tapt Hole in the Inner Engine Wall. The Threaded Flange at the Top of the Bushing Makes the Water Jacket Tight. More Perfect Ignition and Combustion of the Mixture in the Cylinder Is Claimed for This Arrangement, Which Is Common in Racing Cars—Both Plugs Firing Simultaneously.

words more spark plugs. Unfortunately, however, the Ford engine is so arranged that an additional plug cannot be applied direct to the cylinder. The sketch herewith shows how a device can be made that will solve the problem and apply a plug directly over the center of the cylinder right where it performs the best. The addition of this extra plug to the Ford engine will greatly increase the power and will fire much weaker mixtures.

In the sketch (F) represents the section of the cylinder head and (E) the regular plug. (D) is the additional plug mounted in a simple cage (A). This is a very easily made part and can be turned up out of a piece of machine steel or of cast-iron; cast-iron having the same coefficient of expansion is assurance against leaks. This piece (A) is threaded with a 1-inch standard pipe thread where it goes thru the cylinder head, and at the top is threaded with a 1⅞-inch—20thd. U. S. form, at the top where the ring nut (B) clamps down on a gasket (C), thus making a water-tight joint. The walls of this cage are made ¼-inch thick and will stand the explosion force perfectly.

Care should be used to avoid any fractures in boring out the cylinder head to take this cage. If the amateur has not the right equipment for this he should take it to a good machine shop. The cost of boring the four holes will be in the neighborhood of $5. (D) is the additional spark plug and (G) the connecting wire. The whole device is inexpensive in relation to what it accomplishes and with a careful carburetor setting will give greater power on a leaner mixture and a greater mileage. In fact this stunt will allow the use of half gasoline and half kerosene. The results can be considerably improved by attention to the timer, if possible changing same to one having a positive make and break contact instead of the roller.

Contributed by
W. BURR BENNETT,
Member Society Automotive Engineers.

$50.00 IN PRIZES

Paid for "Motor Hints."

Most of our readers have a car of their own, and any number of them have made certain improvements on that car. We want to know about these improvements. What we want are PRACTICAL ideas, not freak stunts. The idea should be simple enough, so that anyone handy with tools can duplicate it. Note that the idea does not necessarily have to be electrical in any way.

We would like to have a photograph of the stunt showing that it was actually tried, but this is not absolutely necessary to win a prize. A simple sketch will do showing the essential parts, etc.

We will pay the following prizes each month:

FIRST PRIZE	$25.00
SECOND PRIZE	15.00
THIRD PRIZE	10.00

All other accepted articles, which win no prizes, will be paid for at the rate of $2.00. Articles submitted should not be long ones. About one hundred to two hundred words will suffice. Address all manuscripts to Editor, "Motor Hints," care of this publication.

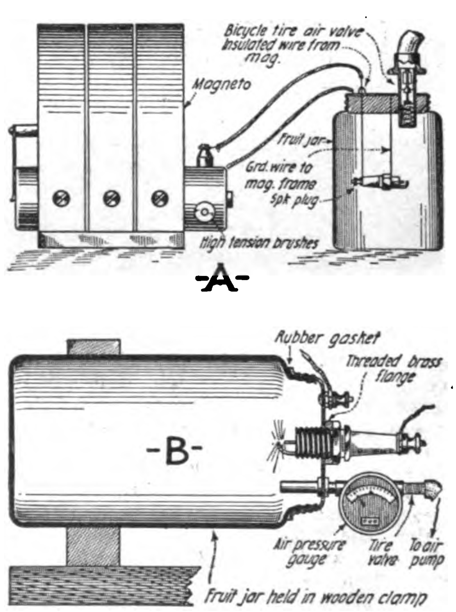
A HOME-MADE SPARK PLUG TESTER

Second Prize $15.00

Having had ignition trouble on a motorcycle, and as it was difficult to ascertain whether it was due to the magneto or spark plugs, I procured an ordinary fruit jar with a removable metal cap. I then drilled a hole thru the cap, and a bicycle air valve was taken from a tire and soldered to the top. Another hole was drilled thru the top and an insulated wire was drawn thru it; the jar was made air-tight with tin or gas-fitters' cement or sealing wax.

Next a ground wire was soldered on the inside and another one on the outside of the cap. The spark plug was attached to the wires on the inside of the cap, and the cap was tightly screwed on the fruit jar, placing a rubber washer between the cap and the jar. Air was then pumped into the jar and the air pressure tested with an automobile tire gage until a pressure of about sixty pounds was reached. The motorcycle engine was turned over and the spark could easily be seen, when the spark plug points were correctly set. An optional form, a little more elaborate, is shown at Fig. "B."

Contributed by LEO ALIG.



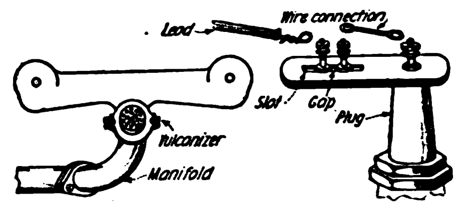
The Gap in the Spark Plug Is About 1/32 inch and the One-Half Inch Spark Given by the Ignition Apparatus Is Greatly Reduced by the Compression in the Cylinder. To Test Plugs Under Compression Conditions, the Plug Is Here Placed in a Glass Fruit Jar with the Top Made Air-Tight and Air Pumped in by Means of a Tire Valve, Together with a Foot or Hand Pump.

GAS INTAKE HEATER AND SPARK INTENSIFIER

Third Prize $10.00

I have tried a great many different devices of my own conception on my car, some of which have proven quite practical.

The *gas intake heater* here shown I have found works very well. A small tire and tube vulcanizer, such as the owner usually carries in the tool kit, is clampt to the intake manifold in such a position that it



Many Suggestions Have Been Given for Heating the Intake Manifold So as to Rapidly Vaporize the Gas from the Carburetor, in Cold Weather, But One of the Simplest Is That Shown Above, Utilizing the Ordinary Gasoline Inner Tube Vulcanizer. The Second Drawing Shows How a Simple Spark Intensifier in the Form of an Auxiliary Gap Can Be Readily Made.

will hold several teaspoonfuls of gasoline. This need not be removed when the motor is started, but may be left in place all winter, or until it is needed for other use. Two spoonfuls of gasoline should heat the manifold sufficiently to vaporize the gas and start the motor running.

A second idea is that of a *spark intensifier*. Instead of paying from one to two and a half dollars each for intensifiers, why not make them at a cost of only a few cents? All that is required is some sheet fibre (Bakelite best) and two dry cell terminals for each intensifier. A slot is cut in the fibre and two terminal binding posts are placed in same. One of the posts is connected to the plug electrode which comes up thru a small hole in the fibre, and the other is connected to the lead from the spark coils or magneto. The posts may be moved up or down the slot, thereby making the adjustment.

Contributed by
DENBY C. STEPHENSON.

HOW TO PULL IN IF YOUR GASOLINE VACUUM OR SUCTION FAILS.

I was in the country ten miles when my motor died with indications that gasoline was not reaching the carburetor, and upon investigation an air leak was discovered around the top of the *vacuum tank*, which stopt the suction of the gasoline from the reservoir. I saved myself from being towed in by removing gasoline from the reservoir and filling the vacuum tank, so that the gasoline would flow to the carburetor. There is a small plug in the center of the top of the vacuum tank which is easily removed to permit the insertion of gasoline. I used a small squirt gun to transfer the gasoline, but in the absence of a squirt gun a paper funnel can be devised, with which to pour gasoline into the vacuum chamber after it has been withdrawn from the reservoir or obtained from some other source. The vacuum holds enough gasoline to run six miles and two operations of a few minutes each enabled me to reach a garage without delay or expense. The point is to get to a garage; and the above stunt will enable you to do it if your vacuum system hangs you up.

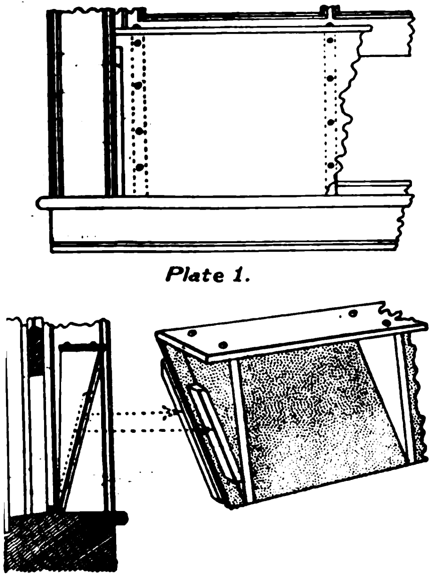
Contributed by ALBERT A. JONES.

Home Mechanics

Conducted by WILLIAM M. BUTTERFIELD

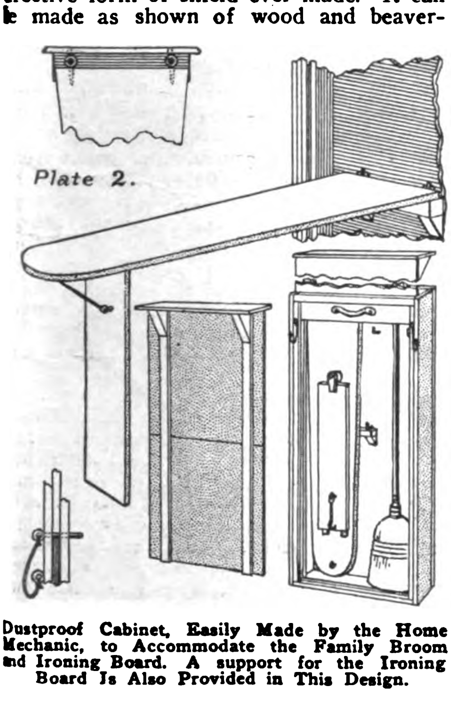
Air Shield for Window

IT would not be much of an exaggeration to say that there have been almost as many kinds of window air shields made as there were people who have used them, for each person has had an individual crotchet as to what a shield should be; so the varieties are almost innumerable. Whether expensive and ornate or inexpensive and simple, the chief object of the apparatus is to keep a room supplied with fresh air, and at the same time prevent rain, snow or drafts from entering the apartment. Various efforts have been made to keep dust from entering as well, but this is asking almost too much of the shield, for to be effective at all, it must let the air come in freely—whether the air is laden with dust or not.



Window Ventilating Board Constructed from a Few Light Pieces of Wood, Some Screws and a Length of Light Wood or Beaver Board. It Slides in Cleats Fastened to the Sides of the Window Frame.

Our figure shows the simplest yet most effective form of shield ever made. It can be made as shown of wood and beaverboard without much trouble and at a very small cost. The whole attachment can then be painted or stained to match the window frame. It has the advantage of being instantly removable, only the cleats at the ends being permanently attached to the window frame. The shield is slid in and out of the cleats at will, for a daily brushing, or for washing the window glass. It can be constructed to fit any window, can be of any height and, if painted, will stand any kind of weather.



Dustproof Cabinet, Easily Made by the Home Mechanic, to Accommodate the Family Broom and Ironing Board. A support for the Ironing Board Is Also Provided in This Design.

Broom and Ironing-Board Cabinet

Every woman's kitchen is clean — we know that—but there are a few things that every woman wants to keep extra clean—removed, as one may say, from the vapors of the kitchen; these are the ironing-board, broom, brushes used for dusting, etc.

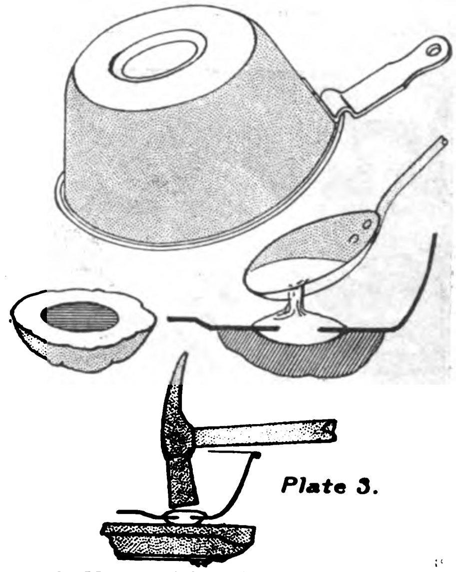
The figure shows a cabinet that is devised to accommodate this desire. It is designed subject to alterations for individual requirements, but consists in all cases of a receptacle for the articles mentioned, and of a support for the ironing-board, as shown. An ordinary ironing-board is made usable with the device, simply by adding screw-eyes at the large end and a hinged board-rest at the rounded end; the attachment for the purpose is fully illustrated. The door slides, like a window, in a groove, and carries the top of the cabinet fastened to it. It is held open with metal pins, past thru holes in the groove cleats. Beaver-board is used for the door, held by wooden cleats, to which the cabinet top is also fastened. The cabinet back can also be made of beaverboard, but in this case the hooks that hold the ironing-board, its shelf and the hooks for the brushes will have to be secured by passing thru the beaverboard back and fastening in the wainscoting of the kitchen wall.

Stopping a Hole in Agateware

We have not all come to the point of discarding agateware cooking utensils for aluminum, and some, therefore, still use the former. Unfortunately, this kind of ware will develop holes in the most unaccountable way, thus putting an otherwise perfect pot or pan out of commission. There is only one safe, home-mechanical way of repairing an implement of this kind, and that is with solder. And fortunately in this instance the housewife can do the job quite as well as the "househusband."

The pictures shown in the illustration herewith give the method without much explanation being necessary. It is necessary, tho, to inform the lady tinker that solder will not adhere to agate surfaces, and that her repairs will be more in the nature of a riveting job than the common one of tinkering. She must for this reason have her solder cover enough of the surface of the outside and exterior to bind and stop the leak, otherwise the rivet will be useless. The procedure is as follows:

First remove grease or dirt from surfaces by scouring with sand, then make the hole at least an eighth of an inch in diameter so that the solder will run thru when melted. Next make a kind of putty by wetting flour or bread, shaping it, with the proper sized depression, as shown, for a mould to hold and shape the solder on the outside of the hole—also illustrated—this putty usually adhering to the agate sufficiently for the purpose. An iron spoon with a wooden handle will answer as the melting and pouring ladle, the solder being melted over a gas or coal fire. When the solder is cooled (say in fifteen minutes) remove the putty and try the vessel with water. If the leak is stopt no riveting is required; otherwise, rivet in the manner shown until it is stopt.



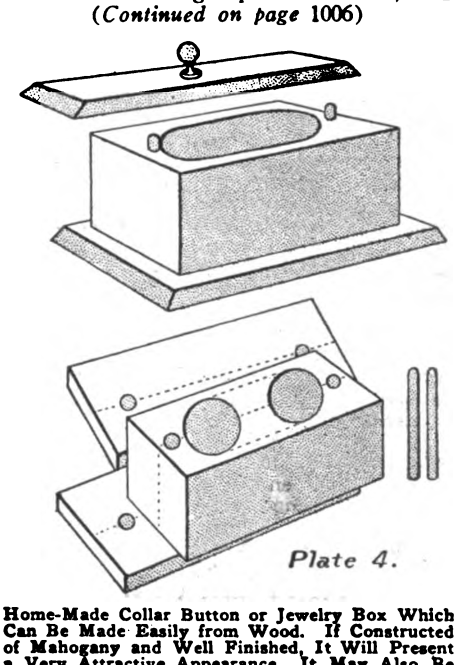
Simple Method of Plugging a Hole in Agate or Similar Kitchen Wear. A Mold Is Made, Formed as Shown, and Hot Solder Poured into the Hole and Afterward Riveted with a Hammer.

Collar-Button Box

Here we show an interesting way of making a collar-button box, or one for containing similar articles. It is held together with wooden or metal pins, and lends itself to variations in size and shape which will make the construction of a number of these boxes, say for Christmas or birthday presents, very fascinating. The ever popular demand for the so-called "mission wood" in articles of this nature will cause them to be received with appreciative pleasure, while the inventive genius of the builder in creating new combinations or forms will be found equally attractive.

The principle of construction is to make the box of a single piece of wood, and

(*Continued on page* 1006)



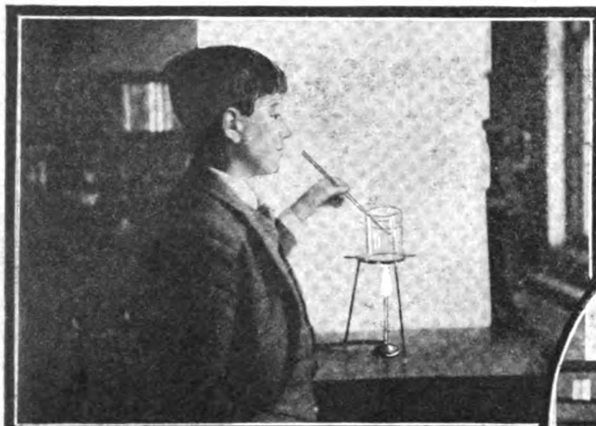
Home-Made Collar Button or Jewelry Box Which Can Be Made Easily from Wood. If Constructed of Mahogany and Well Finished, It Will Present a Very Attractive Appearance. It May Also Be Gold Lacquered.

Practical Chemical Experiments

By PROF. FLOYD L. DARROW

METALS AND THEIR ALLOYS

ONE of the earliest chemical facts to be discovered was the ease with which certain metals would alloy, or fuse together, when placed in the melting pot and subjected to heat. It was also early discovered that these new combinations of metals often of the utmost significance to the industrial progress of the world. As we shall see, the addition of very slight amounts of various metals to steel has wrought marvelous changes in its properties. In recent years the fabrication of new alloys for specific purposes has become an art in itself and ingly simple process but an interesting one. For those alloys having a low melting point only a fire clay crucible, Bunsen burner and ring stand are required. For those of higher melting point either a forced draft or some form of electric furnace will be necessary.

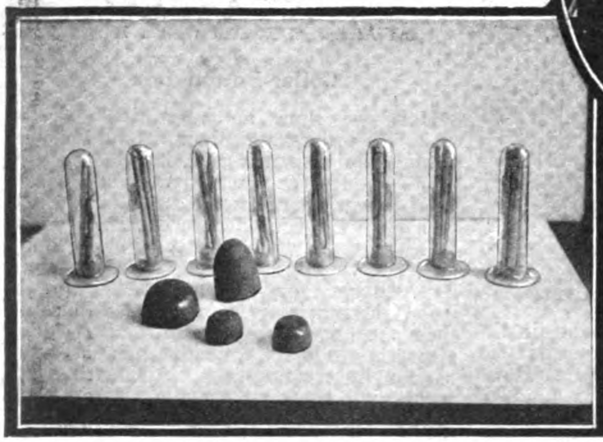


Melting Wood's Metal in Hot Water.

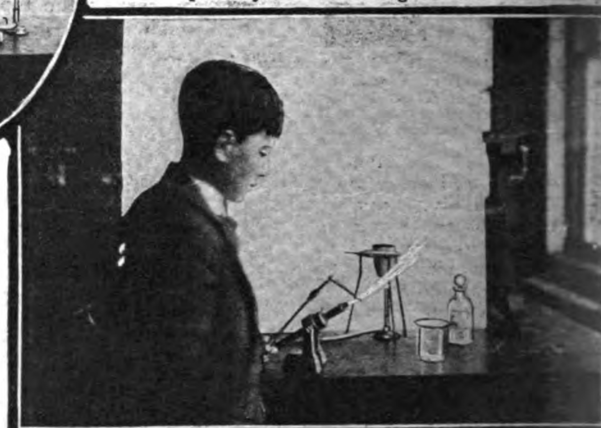
Below — Making Solder in the Chemical Laboratory. A Small Crucible Contains the Ingredients, Which Are Heated by Bunsen Gas Burner.

Removing the Crucible of Molten Brass from the Electric Furnace, Preparatory to Plunging It into a Jar of Cold Water.

Samples of Alloys Made by Boys: Pewter, Solder, Type Metal, Wood's Metal, Bronze, Brass and Aluminum Bronze.



Heating an Iron Nail in the Blast Lamp Flame, Preparatory to Galvanizing It with Zinc.



possest properties which made them vastly superior for many purposes to the individual metals themselves. Thus, bronze, which was probably the first alloy to be made, was much harder and better adapted to fashioning weapons of warfare and domestic implements than either of its constituents, copper or tin. Bronze, too, was known long before primitive man had mastered the metallurgy of iron and steel and those early metal workers were actually able to temper this alloy and make it take a cutting edge—something that now seems to be one of the lost arts. With weapons and implements of bronze the cave men of Europe slew the savage beasts, fought their enemies and later felled the forests and tilled the soil. But following this first and tremendously important alloy has come a host of others, no less useful to the race. Indeed alloys are among the most valuable products of the metallurgist's art and some of the greatest triumphs of modern chemistry are associated with this work.

An alloy is a uniform mixture of several metals which have been melted together. The metals may be mixed in any desired proportions and are therefore not chemically combined. Each metal is present in the free state and yet such a combination of metals in some way, not well understood, modifies in a wonderful degree the physical properties of the constituents.

The preparation of alloys is an exceed-

The Preparation of Solder

For our first alloy we will select on which has a low melting point and is eas to make. Arrange a ring stand, Bunse burner and fire clay crucible as shown i Fig. 1. Into the crucible put equal part by weight of lead and tin. Using a smal flame at first, gradually increase the tem perature until all of the metal has melte down into a uniform mixture.

For shaping the so der into sticks, have a hand a plaster of Par mould. This can b made by mixing th plaster of Paris in box cover and whi still soft pressing into two or three lead pen cils. Into these depres sions pour the molte metal and allow it t solidify.

The Pewter fro which the tableware o early Colonial days wa made consisted of a

(Continued on page 1016)

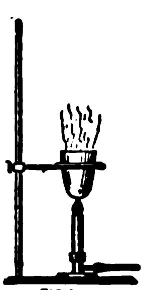


FIG.1

Apparatus for Making Low Melting Point Alloys.

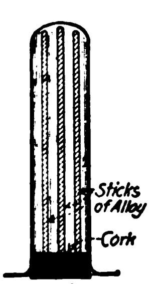


FIG.2

Glass Specimen Tube for Mounting Preparations.

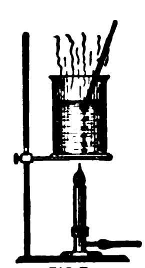


FIG.3

Melting Wood's Metal in Hot Water.

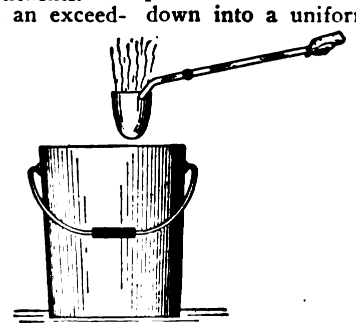


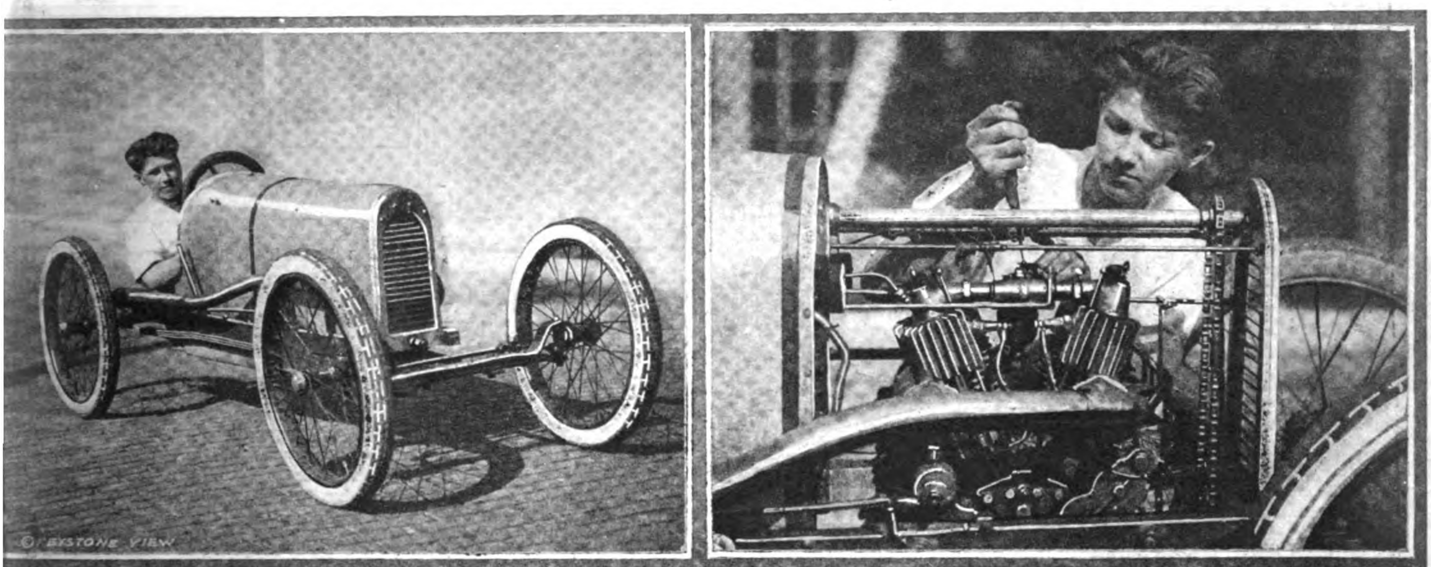
FIG.4

Plunging Crucible of Molten Bronze into Pail of Water.

THE CONSTRUCTOR

Building A Small Automobile

By H. Winfield Secor



The Two Photographs Above Show Master Harry Habig, a Youthful Automobile Builder Who Surprised Even Himself in the Speed Attainable with His Home-Made Motor Car. He Had Calculated that It Would Travel Along at About 30 Miles per Hour, but the Machine Developed Over 40 Miles an Hour. The Car Is Driven by a Motorcycle Engine.

IT took Harry Habig, a youthful automobile builder, a whole year to build the miniature automobile illustrated from parts of an old motorcycle, some from an old bicycle and still other parts which were original and which he had to make himself. But when it was finished it was no disappointment, for he figured right when he said it would go some better than 30 miles an hour. It developed over 40 miles an hour and Habig avers that, after he has substituted a chain drive for the present belt drive, his midget racer will travel 70 miles an hour!

The unique little racer has a six-foot wheel base. It is equipt with a two-cylinder motor, taken from a motorcycle, and contains a double ignition system. The springs were tensioned and bent by himself. He also installed in the machine a new idea in the steering system. The steering wheel shaft extends horizontally to the front of the machine and fastens into the top of the radiator where an endless driving chain taken from an old bicycle connects by means of sprockets to the steering mechanism of the front axle.

This miniature speedster weighs less than a thousand pounds and travels 42 miles on a measured gallon of gasoline.

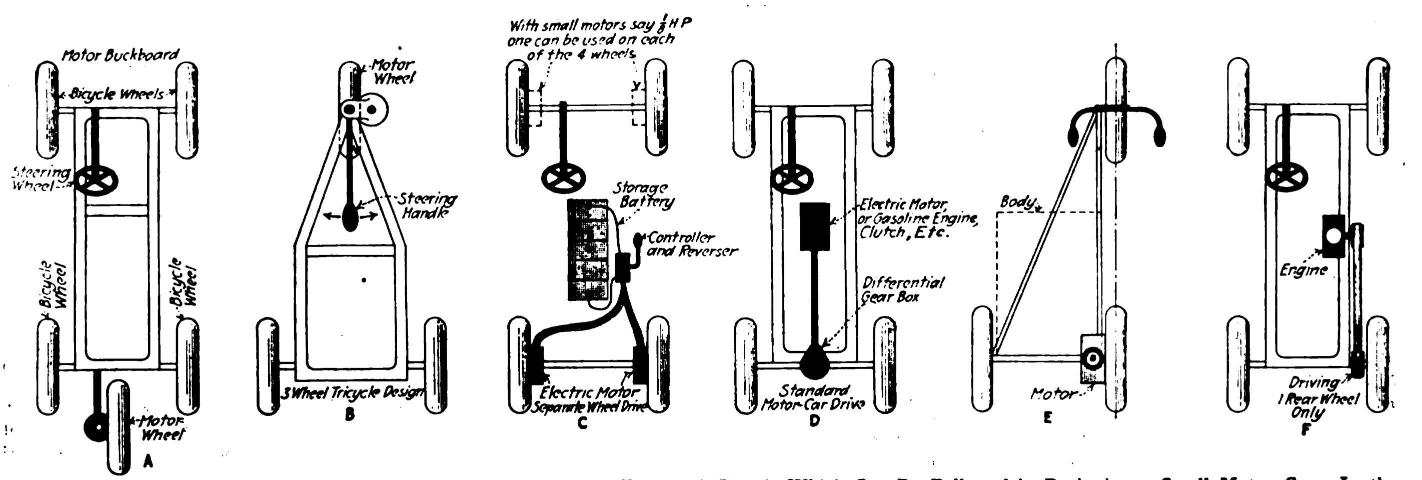
The youthful inventor and builder is only fifteen years old and is attending the first year class at the Ohio Mechanics Institute. He has built two model submarine chasers and several model airplanes which were on exhibition at the Institute.

A Small Home-Made Automobile

Youthful Master Habig started something when he built his miniature automobile—at least he influenced the Editor's ideas to the extent of preparing a short article on the subject and featuring some pertinent principles which can be easily worked out by the multitude of young motoring enthusiasts who may desire to build a small motor tricycle or runabout.

The great desire of almost everyone is to ride rather than walk, and while motorcycles are becoming more commonly known and employed every day, the commercial machines cost almost as much as a full-sized automobile, and therefore, many people cannot avail themselves of the privileges engendered by owning one of these machines.

A gasoline motor rated at 1½ to 2 horsepower such as employed in the Smith motor wheels as well as in several other motor drive attachments for introducing motors on bicycles, are sold on the open market at a very reasonable price, either



Figs. 1A to 1F, Inclusive, Shown Above, Illustrate the Principal Forms of Chassis Which Can Be Followed in Designing a Small Motor Car. In the Accompanying Article Details and Reasons for Using the Various Forms of Drive, Employing Both 3 and 4 Wheels, Are Thoroly Discust. The Simplest Machine, Employing No Differential Gear, Is the Three-Wheel or Tricycle Design Indicated at B and E.

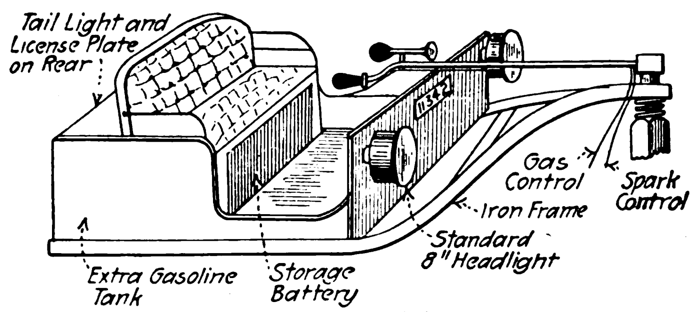


FIG 2-A

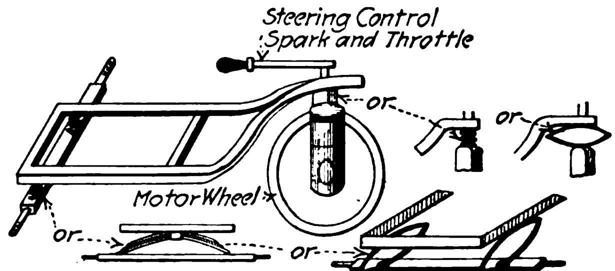


FIG. 2-B

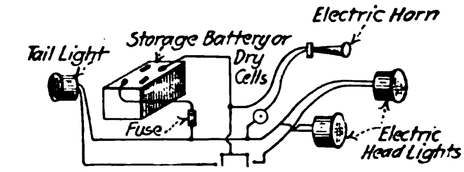


FIG. 2-C

Fig. 2. Details Are Suggested Above for Building the Body and Iron Frame of a Three-Wheel or Tricycle Design of Small Motor Car. The Body Can Be Built in Several Different Styles of Course, but the Principal Element Is "Lightness," Unless Quite a Powerful Engine Is to Be Used. The Frame May Be Built of Angle Iron or Better Still of Steel Channel or U-Beams, Measuring About 2x2 Inches in Either Case.

new or second-hand, for constructing a small machine of the type outlined in the following description.

General Types of Small Automobiles

About the first important factor to be considered in designing or building a small motor tricycle or buckboard is the arrangement and disposal of the wheels and the power plant. At Fig. 1, there are shown the six principal methods which should be followed in propelling a small automobile.

Fig. *A* shows the design followed in building a small motor buckboard which the writer of this article had the pleasure of seeing in actual operation last summer. This machine measured about six feet in length between the axles and about three feet in width, and it contained two seats, often carrying a load of two adult passengers weighing about 135 pounds each.

The four wheels, numbered 1 to 4, in this case, are simply four bicycle wheels and may be used with or without ball bearings, the ball bearings causing the machine to run much more smoothly and easily, of course. The motor wheel, complete with engine, gasoline tank, etc., of a well-known type, was secured with an iron frame to the rear of the vehicle, in the manner shown.

The front wheels were turned to right or left by a steering wheel of the usual type. Resiliency to a fair extent is obtainable in these automobiles, by the use of springs placed between the body and axles, or by employing the buckboard principle. This involves the use of a number of slats or strips of some tough springy wood, such as hickory or spruce. The strips should usually measure about 2" by ⅜", and are bolted on top of the front and rear axles, or to a piece of channel iron attached to the axles. The spark and throttle control rods from the motor wheel are carried forward to the driver's seat, so as to be convenient.

One of the simplest and best designs, efficiency and other things considered, is the three-wheel disposition and drive shown at Fig. *B*. This is the famous tricycle principle so widely followed by the European builders of small motor vehicles, some of which carry three and four passengers with but a small engine.

The bugaboo that scares many of the would-be miniature auto builders, in most cases, is the complex machinery required in applying the driving power to the rear axle involving the well known compound gearing, known as the "differential," which device distributes the power from the main driving shaft to the two rear axles and wheels evenly, no matter at what angle the car may be turning.

The point should be kept in mind in the present argument that in turning a corner or a circle, the outer wheel of the car on the same axle should be able to rotate faster than the one on the inner or smaller part of the circle or curve. This is the principal reason for the differential gear found in the center of the rear axles of all modern cars. To eliminate this most expensive and important part of motor car machinery, has suggested to the minds of the builders of small motor vehicles, particularly of the European manufacturers, the employment of the well-known three-wheel tricycle, shown at Fig. *B*, and the writer has given herewith, several drawings and pointed out some of the simplest ways in which to build a machine of this type.

Before going further, we will consider several other methods of driving a motor vehicle. Fig. *C* shows an electric car for those who have or wish to build storage batteries and drive their machines by means of electric motors.

Electric vehicles have been built for several years, at least some types of them—without a differential on the rear axle and with the two rear wheels driven by separate motors in the manner shown at Fig. *C*. For a small machine of the buckboard or similar type, and light in weight, the two motors, if applied to the rear wheels, may develop about one-quarter to one-half horse-power each. Generally speaking, a small motor vehicle of this type, about six or seven feet long between axles, and utilizing bicycle or motorcycle wheels, will require about one-half horse-power at least, to drive the machine at a speed of eight or ten miles an hour.

Commercial machines have also been built, and are in present-day use, employing a relatively small electric motor applied to each of the four wheels. A condition may arise where the prospective motor car builder will have available four small motors rated at one-eighth to one-quarter horse-power each, let us say. These can be used in the manner shown at Fig. *C*, applying the motor thru a gear, one to each wheel. A pinion should be placed firmly on the shaft of an electric motor and a larger gear with about 10 to 15 times as many teeth as on the pinion is to be secured to the wheel.

(*Continued on page* 1020)

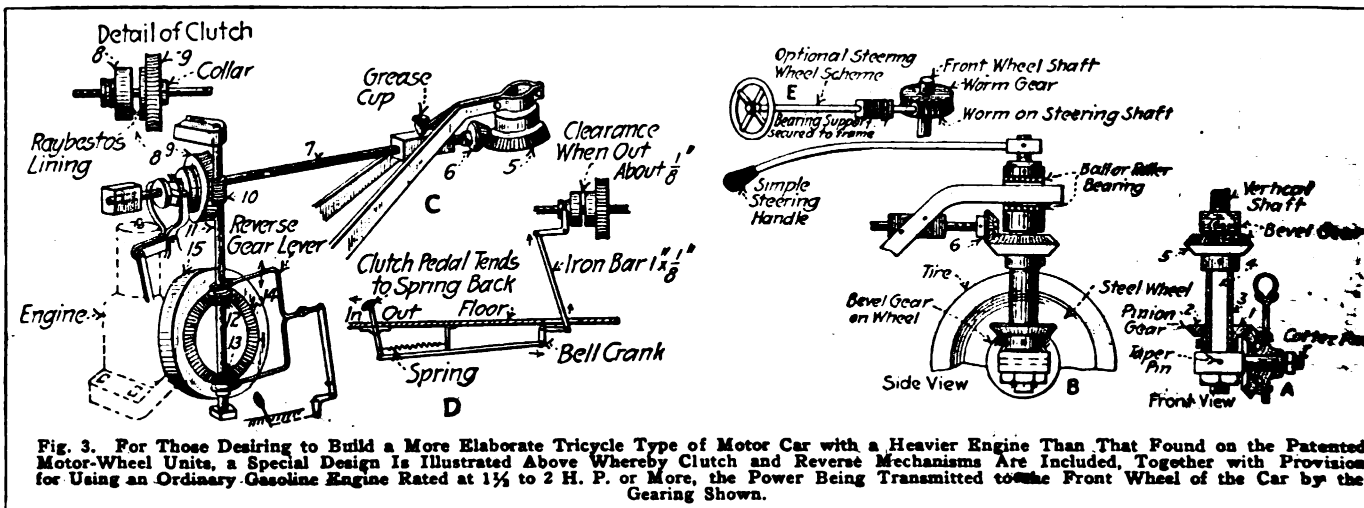


Fig. 3. For Those Desiring to Build a More Elaborate Tricycle Type of Motor Car with a Heavier Engine Than That Found on the Patented Motor-Wheel Units, a Special Design Is Illustrated Above Whereby Clutch and Reverse Mechanisms Are Included, Together with Provision for Using an Ordinary Gasoline Engine Rated at 1¼ to 2 H. P. or More, the Power Being Transmitted to the Front Wheel of the Car by the Gearing Shown.

Bench Drill from Pipe Fittings

By R. E. NELSON

THE accompanying photograph shows a bench drill which the writer constructed from scrap pipe fittings and odds and ends about the shop. Cast fittings should be used as they add to the rigidity of the frame. The photograph shows the motor mounted on a box over the rear bearing but its position may be varied to suit the builder. A snap switch with fuse block mounted on the side of the box controls the motor. Five sixteenths or ⅜" round leather belting is large enough to drive the drill to full capacity.

Frame

For the frame the following pipe fittings are required:

- One half of a 1½" Flange Union—"Y" fig. 2.
- 1 Nipple 1½" x 10½" E. H. Pipe—"Z" fig. 2.
- 1 Nipple 1" x 5" E. H. Pipe—"U" fig. 2.
- 1 Nipple ¾" x 4½" E. H. Pipe—"N" fig. 2.
- 1 Nipple ¾" x 4¾" E. H. Pipe—"N" fig. 2.
- 1 Cast Tee 1½" x 1½" x ¾"—"X" fig. 2.
- 1 Bushing 1½" x 1"—to fit top of "X."
- 2 Cast Tees ¾" x ¾" x ¾"—"C" and "C."
- 1 Cast Tee 1" x ¾" x ¾"—"Q" fig. 2.
- 1 Piece 2" x 8" x 24" Oak S4S for Base.

Cut and thread the nipples as per dimensions in figure 3 and assemble the frame. Bolt it to the oak base and test it for rigidity and alignment. Larger fittings can be used by bushing them down in case the above sizes are not obtainable. When in its lowest position the chuck is 4½" from the base and as no table has been provided for bringing the work toward the drill, a few wood blocks of various thicknesses should be provided for adjusting the work to the proper height.

Chuck and Spindle

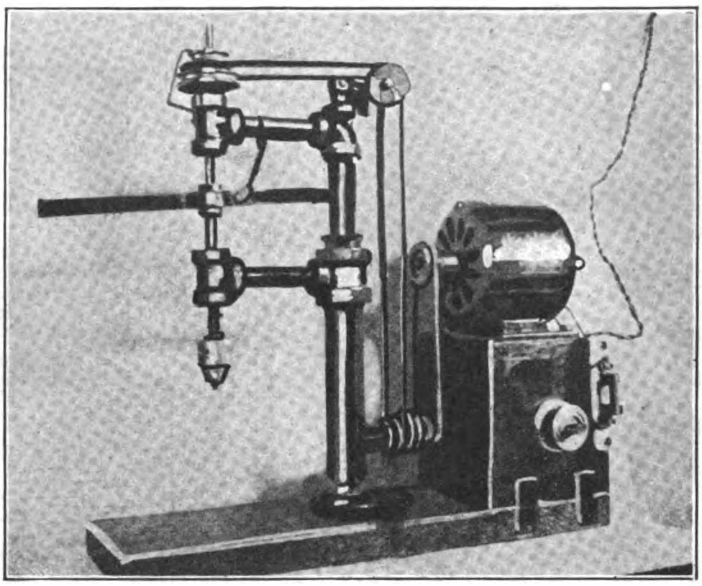
The chuck "A," figure 2 should be purchased as it is beyond the scope of the amateur. Get one that has a ½" shank which screws into the top of the chuck body and operates the jaws. This shank should be removed and the spindle threaded to fit in its place.

The spindle "B," figure 2, is turned from machine steel to dimensions shown in figure 3 and a keyway is cut in the upper end as shown. The spindle slides up and down thru the pulley "H" while the key "I" is relied upon to drive the spindle. The lower end of the spindle is threaded to fit the particular chuck purchased. The spindle pulley "H," figure 2, is shown in detail in figure 3. The best material to make it from is cast iron or brass. A 1/16" x ⅛" keyway is cut in the pulley to correspond with the one in the spindle. Make the key "I," figure 3, next and make it fit very tightly in the keyway of the pulley but have it fit loosely in the keyway in the spindle so that the spindle can be raised and lowered while the pulley "H" is driving it. As a further precaution to prevent the pulley "H" from rising when the spindle is raised make a small piece "G," figures 2 and 3, and fasten it to the upper tee with machine screws.

An easy way of cutting the keyways in the spindle and pulley is as follows: While the work is still between centers or in the chuck place a cutter with an ⅛" face sideways in an Armstrong holder or boring bar so that the cutting edge is toward the headstock. Run the carriage back and forth by hand and at the same time advance the cutter and a perfect keyway will be cut. Care must be taken to lock or clamp the headstock spindle so that it cannot rotate or shift its position even so much as a 1/100 of an inch or the keyway will be imperfect.

Feed Device

The easiest feed device to construct is a lever feed. It consists of the following parts: the lever "F," figures 2 and 3, which is hinged to the piece "P" by a stove bolt, two collars "D" and "D'" which are pinned to the spindle and the collar "E" which fits loosely between them but is not pinned to the spindle and does not rotate with it. Collar "E" has two projecting pins fastened to it (figure 3) which engage in the holes "O" and "O'" of the lever. The feed device operates as follows: When the lever is prest down, the two pins which are fastened to the collar "E" and which engage in the holes "O" and "O'" of the lever, cause the collar "E" to move down with the lever, but, the collar "E" bears against the collar "D" which is pinned to the spindle, and consequently the spindle is fed down with the lever. When the lever is raised collar "E" bears against the upper collar "D'" and the spindle is raised.



The Finished Bench Drill Constructed From Pipe Fittings.

Make the lever "F," figure 3, by riveting two pieces of ⅛" x ¾" strap iron together. The loop is made by bending the pieces around a 1¼" bar. The ¼" holes "O" and "O'" in which the pins and collar "E" engage are drilled on opposite sides of the loop as shown. Drill two ¼" holes in the end of the lever where it hinges to the piece "P" and file them out to form a slot. Unless this is done the holes "O" and "O'" will describe an arc and the spindle will bind. Make the anchor piece "P" from a piece of strap iron and fasten or clamp it to the nipple "U" with machine screws or a stove bolt. A stove bolt will do to hinge the lever on. A small spring keeps the spindle raised when the lever is released.

The two collars "D" and "D,'" figure 3, are similar and are turned from brass. They should fit the spindle very snugly. Turn up the collar "E" from brass also and have it fit loosely over the spindle. Drill a ¼" hole right through the collar edgewise and fit two pins in it letting them project about ½" to engage in the holes "O" and "O'" of the lever. To locate the position of the collars "D" and "D'" on the spindle proceed as follows: place the collar "D" on the spindle with its lower face 9" from the upper end of the spindle; and over it place a washer made from heavy paper. Next put the collar "E" in place and put another paper washer over it and then put collar "D'" on top. Clamp the three collars together and drill a ⅛" hole edgewise thru collar "D" and slip a pin in it to keep the assembly in place and then drill a similar hole in collar "D.'" Remove the clamp but do not remove the pins so that the location of the collars will not be disturbed until the spindle is finally put in place. If it becomes necessary to remove the collars for any purpose be sure to mark them with punch marks or otherwise so that they can be put back in the same position that they occupied before. It will, of course, be necessary to remove the paper washers before the drill is run.

Belt Tightener

The belt tightener and idler device consists of a plug "M," figure 2 and 3, threaded to fit the top of the tee "Q" and slotted as shown. In the slot is clamped the carrier "K" which holds the shaft "L" on which two pulleys, "J" and "J,'" rotate in opposite directions. Make the plug "M" from brass or soft steel and thread it to fit the tee "Q." Cut a slot in it as shown in figure 3 and drill a hole for a clamping bolt. The carrier "K" is made from soft steel and slotted as shown in figure 3. A ⅜" hole is drilled at the large end for the shaft "L" which is a piece of ⅜" round soft steel polished up and threaded at each end for a nut. It should be driven into the ⅜" hole in the carrier "K" and pinned if necessary so that it will not rotate. The two pulleys "J" and "J'" are similar and should be made from brass, iron or hard babbitt. They should rotate freely on the shaft "L."

Drive Shaft

The drive or countershaft parts should next be constructed. There are five parts to these: a shaft "T," is supported at each end by the bearings "S" and "W" which are described in detail later on.

Turn up the shaft "T" from soft steel as per dimensions in figure 3. The three-step cone pulley should next be turned up from a piece of cast iron or brass or hard babbitt. The babbitt is just as good as the cast iron or brass and can be easily cast in the home work-shop. It is also very easy to machine. The detail dimensions are shown in figure 3. Hold the casting in a chuck or clamp it on a face plate and bore a 7/16" hole thru the center. With an inside boring tool bore out the diameter to a scant ½" or just enough so that the shaft "T" will fit very tightly in the hole. If this is done it will be unnecessary to use pins or set screws to fasten it to the shaft. Use the same method in turning up the pulley "V," or if desired, both pulleys may be turned in one piece.

(*Continued on page* 1004)

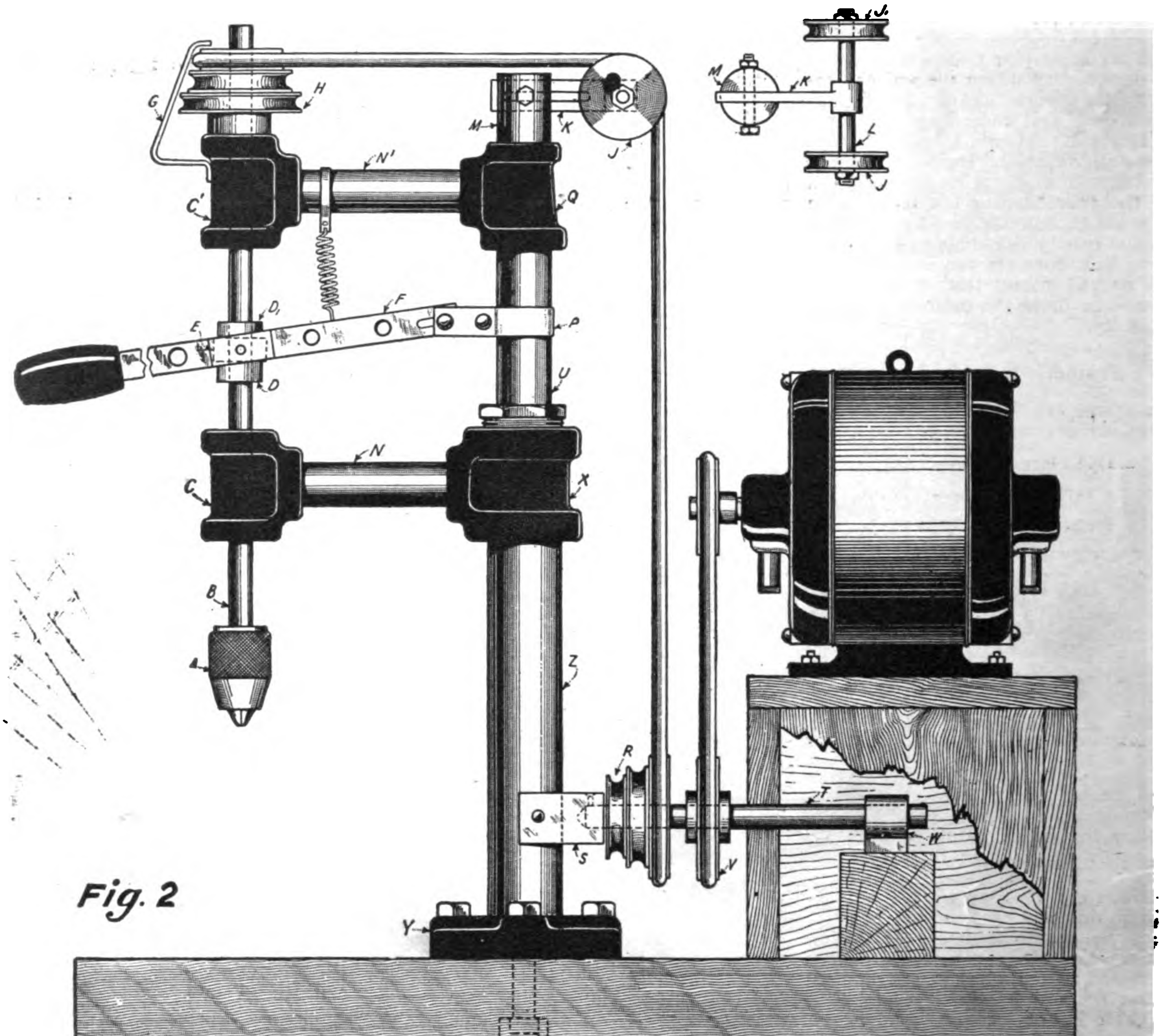


Fig. 2

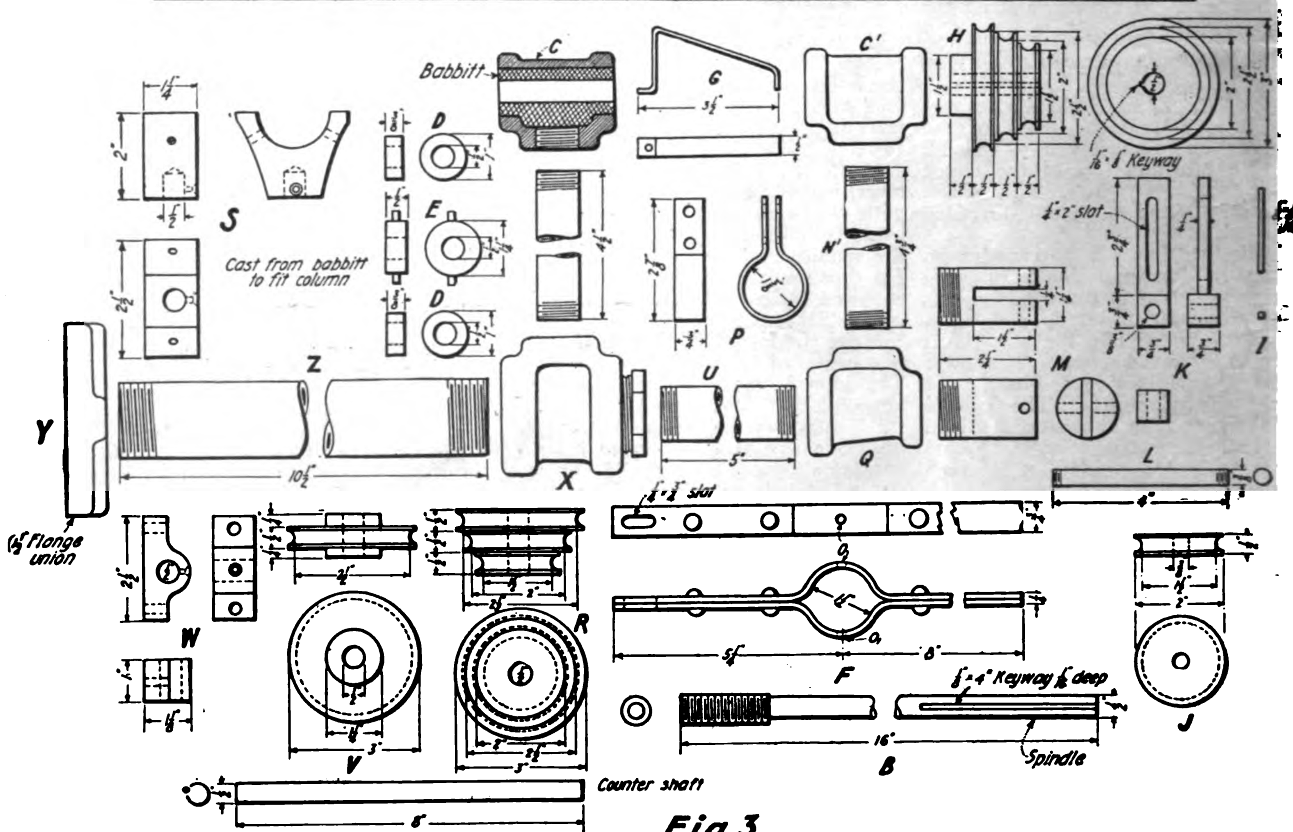


Fig. 3

Full Description on opposite page

Perpetual Motion Prize Winner

In the October, 1920, issue of SCIENCE AND INVENTION we publisht a special "Perpetual Motion" article submitted by Mr. d'Abro, who offered a ten-dollar ($10.00) prize for the best explanation as to why this machine (reproduced in the illustration herewith for the benefit of our readers who did not see the original article) would not successfully operate.

We received about 1,500 letters, the majority of the writers of which did not definitely explain why the machine would not operate perpetually, without committing themselves to a host of misstatements of the laws of physics, which automatically ruled them out.
These letters were examined by several scientific men of high repute, including among others Prof. T. O'Conor Sloane, Ph.D., LL.D., and the editors, H. Gernsback, E.E., and H. W. Secor, E.E.

The letter to which the $10.00 prize has been awarded, together with several of the next best letters, are publisht herewith.—The Editors.

[MR. d'ABRO'S ARTICLE REPRINTED BELOW.]

IN your February issue you publisht different answers to your "Perpetual Motion Prize Contest."

The first prize is allotted to Mr. Burgin, who claims that your first perpetual motion device will not work because of the buoyancy of the rubber chambers being the same on either side.

According to Boyle's law, this would mean that the pressure of the imprisoned air is the same whether the weight be crushing the rubber cylinder down or whether it be stretching it lengthwise.

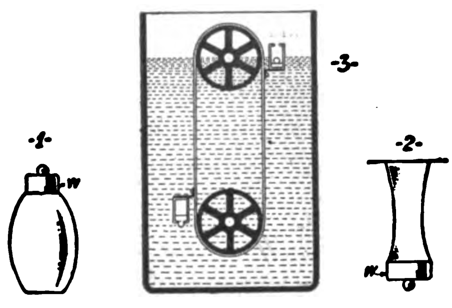
Surely this is incorrect. Assuming that the cylinders contain air at atmospheric pressure and are immersed in the atmosphere, when the weight presses down the top of the cylinder the walls bulge out and the cylinder assumes the form of a barrel—when a state of equilibrium is reached. (See Fig. 1.)

The pressure of the imprisoned air on the top surface of the cylinder is sufficient to counteract the push of the atmosphere, plus the push of the weight—thus the pressure of the imprisoned air is increased.

On the other hand, when the weight is suspended at the base of the cylinder the tendency is to lengthen the cylinder; thus increase the volume of the imprisoned air and decrease its pressure. (See Fig. 2.)

The outside atmosphere will push in the walls of the cylinder and create a waist. Finally when a state of equilibrium is reached, the interior push on the bottom of the cylinder will be equal to the atmospheric push on the bottom, minus the weight, thus the interior pressure is reduced.

I am assuming for simplicity's sake that the bottom and top of the cylinder are rigid and only the walls elastic.



Three Phases of the Recent Perpetual Motion "Water-Bucket Machine" Which Formed One of the Problems of the Prize Contest Some Months Ago. Mr. d'Abro Offers a Ten-Dollar Prize ($10) to Anyone Who Can Give a Successful Explanation to the Questions He Here Propounds. All Answers Must Be in the Editor's Office by October 15, 1920.

In short, according to Boyle's law, the buoyancy cannot be the same on both sides and the device must rotate—and yet, of course, it will not!

May I suggest a slight modification of your highly ingenious device? Instead of rubber pockets let us consider metallic cylinders in which pistons can run without friction, and let us fix the weights to these pistons and place rings at the extremities of the cylinders to prevent the pistons from slipping out. Let us suppose that the cylinders contain no air, and let us place the device in water.

When the weights press down the pistons toward the bases of the cylinder, the pistons will come in contact with the bases of the cylinders, since no air is interposed—when the weights pull the pistons down away from the bases of the cylinders the pistons will glide down to the other extremities of the cylinders until arrested by the rings. (See Fig. 3.) To obtain this result it will be necessary for the weights to be of sufficient magnitude to overcome the cumulative effect of the atmospheric pressure, plus the hydrostatic pressure—theoretically, at least, this is possible.

In this modified form the increase in volume and thus of buoyancy of the cylinders is manifest, and the device should undoubtedly rotate. If not, why not?

Could any of your readers explain the reason? I hereby offer a ten-dollar prize for the best answer.

(Ed. Note.—*Mr. d'Abro has deposited the $10.00 prize money with us. Send all letters of explanation to Perpetual Motion Editor,* Science & Invention, 233 *Fulton St., New York City.*)

Prize Winner and Honorable Mention Awards

ERNEST K. CHAPIN

$10.00 Prize Winner

I herewith submit an explanation of why Mr. D'Abro's perpetual motion machine would not operate.

The upward force of buoyancy which is supposed to operate the machine is gained at the expense of the lowering of the weight in the cylinder which is rising. Additional energy must therefore be applied to the machine sometime during each cycle to boost this weight over the top for another trip. This fact will be seen clearly if one considers the lowering weight to have yielded all of its potential energy and to have reached the lowest point in the cycle. The rising weight will at this instant not be at the top but will have yet to travel a distance equal to the length of the cylinder. Where is this energy coming from?

Ernest K. Chapin.
138 Merrill Ave., Muskegon, Mich.

First Honorable Mention

Assuming the conditions given are fulfilled, i. e., that the weight of the piston is of a magnitude greater than the combined weights of a water column and atmospheric column of equal horizontal area, and that the piston's motion within the cylinder is frictionless, and that as a result there is an unbalanced force sufficient to produce clockwise motion, as shown in Fig. 1, it is obvious that the very assumption we have made to get our piston into operating position is the thing which defeats our purpose for, there being no friction between the piston and cylinder walls, no force can be transmitted from one to the other and the piston will therefore *move up into the cylinder* until a condition of equilibrium is established.

Now let us suppose that the cylinder is equipt with a device which will lock the piston in position for upward motion, as in Fig. 1. Then there will be upward motion until a position is reached as shown in Fig. 2. At this point we have the weight of the cylinder and piston *in air* acting thru an equal lever arm against the weight of the cylinder and piston *in water* (which equals its weight in air minus the weight of water it displaces) and we will now find that the force tending to produce motion is in the *opposite direction* to that in Fig. 1, and we will therefore have no rotation.

Edward H. Prentice.
60½ North Street, Binghamton, N. Y.

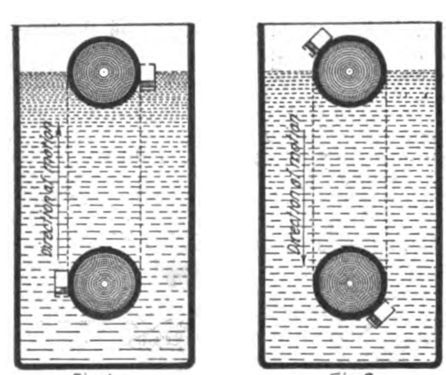


Fig. 1 Fig. 2

Diagram to Accompany "First Honorable Mention" Explanation of Perpetual Motion Problem.

Second Honorable Mention

The following is my answer to the perpetual motion scheme in the October Science and Invention:

There is, it is true, a constant force acting upward on the left-hand side. This force is equal to the *weight of the water contained by one of the cylinders.* But we must remember that every time a weight drops toward the ring on the cylinders, a volume of water (equal in weight to that contained in the cylinders) is forced downward in the opposite direction to the supposed perpetual motion.

I think that even without a technical proof it is quite evident in a general way that these two forces offset each other, for they are in opposite directions, and equal (since they both equal the weight of the same volume of water).

Louise L. Sloan.
Pembroke West, Bryn Mawr College,
Bryn Mawr, Pa.

(*Continued on page* 1015)

HOW-TO-MAKE-IT

This department will award the following monthly prizes: First prize, $5.00; second prize, $3.00; third prize, $2.00.
The purpose of this department is to stimulate experimenters toward accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department a monthly series of prizes will be awarded. For the best idea submitted a prize of $5.00 is awarded; for the second best idea a $3.00 prize, and for the third best a prize of $2.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $5.00

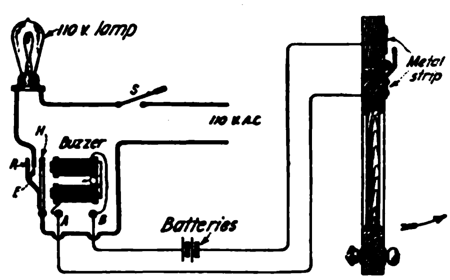
A DOOR ALARM.

The main apparatus of this alarm consists of a common buzzer used as a relay, which is arranged in the following fashion: The wire from binding-post A is joined to one magnet, and the wire leading to the other magnet connects to post B. This cuts out the circuit-breaker.

The strip R is bent about breaker E, so that it does not touch E unless the armature is attracted by the magnets. The action is as follows: When the door is opened, contact is made between the two metal strips, one on the door-jamb and the other on the door. Current from the batteries then flows thru the magnets drawing over the armature H, the contacts closing the circuit for a visual signal and announcing in this way that the door has been opened. The signal should be placed conspicuously.

The current from the 110-volt circuit then passes thru R to E and lights the lamp; a switch is provided at S to turn off the signal.

Contributed by C. R. WADGE.



A 110-Volt Lamp Signal, Controlled by a Relay Made from an Ordinary Buzzer, the Lamp Flashing on When the Door Is Opened.

WIRING COMPUTATION

Frequently electrical workers find themselves in the predicament of not having at hand a pocket reference book containing wire tables giving the different sizes of wire necessary to carry various currents over certain distances. The resistance of the circuit both ways equals the drop in volts in the circuit, divided by the current in amperes passing thru the circuit.

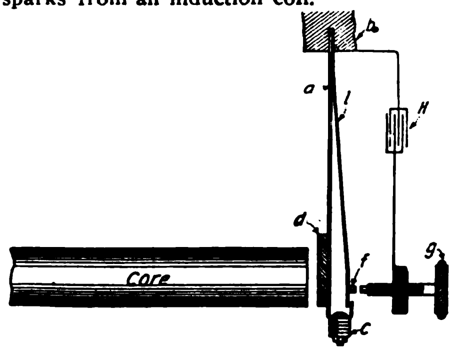
Suppose for example, we have a group of incandescent lamps requiring a total current of 10 amperes and that this lamp group is to be fed with current over a distance of 250 feet. This would mean that the length of the two wires would be 500 feet. The average potential drop allowable in a circuit of this type is 4 volts. Then we find the total resistance in the circuit, 500 feet of wire (exclusive of the resistance of the lamps) would be four divided by ten, or .4 ohm. This means that the resistance of the 500 feet of wire in the 250 foot run would be .4 ohm, or 1000 ft., of the wire would have a resistance of .8 ohm.

Looking this up in a standard B. and S. gage wire table, we find that No. 9 B. and S. gage copper wire corresponds to a resistance of .8 ohm per thousand feet.

SECOND PRIZE, $3.00

MECHANICAL INTERRUPTERS.

In the figure is shown a very efficient and simple mechanical interrupter that was designed especially for producing long sparks from an induction coil.



This Type of Interrupter Will Produce the Longest and Most Powerful Sparks from Induction Coils, Owing to the Long Make and Short Break Effect. "H" Is the Usual Condenser.

Referring to the figure, (a) is a stiff bronze spring fastened at (b) and weighted at (c) so as to give the desired frequency of vibration. This spring carries a soft iron armature (d) opposite the end of the core of the coil; (l) is a light spring of bronze, also fastened at (b), carrying a contact point (f) for making contact with the adjusting screw (g) thru the contact points.

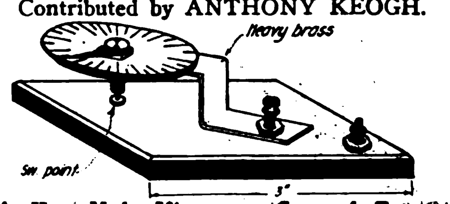
Both may be of platinum—iridium or silver. This spring normally rests against the screw, closing the battery circuit until spring (a) is attracted far enough so that the hook on spring (a) engages the end of spring (l) and opens the circuit. When this vibrator is properly adjusted spring (a) will vibrate very vigorously thru a wide arc, while spring (l) will close the battery circuit long enough to allow the core to become magnetically saturated, and then it will break the circuit very fast.

Contributed by
PHILIP G. BERNHOLZ.

HOME-MADE MICROMETER

A necessary but seldom found tool in the average experimenter's "lab" is a micrometer. This instrument takes the place of one. The scale is graduated in thousandths of an inch, and may be used as a "mike" or a wire gage. If a bell and battery are connected in series with it, the bell will ring when the indicator is on the right spot. It may also be used as a key, if the brass arm is made springy enough. The arm is from a telegraph sounder, while the lower anvil is a switch point.

Contributed by ANTHONY KEOGH.



A Home-Made Micrometer Gage of Extreme Simplicity.

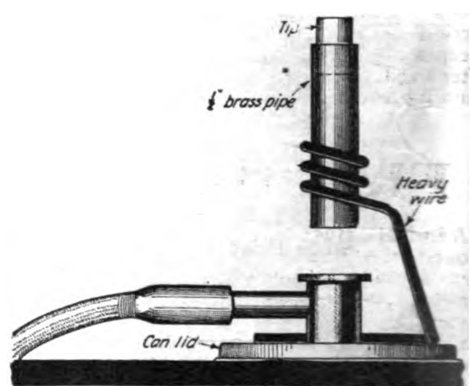
THIRD PRIZE, $2.00

THE CHEAPEST BUNSEN BURNER.

Herewith is a diagram of a Bunsen burner which can easily be made by the experimenter and will be found useful in the laboratory and shop.

A piece of half inch brass pipe (toilet supply pipe will do) 2⅛ inches long forms the barrel and a ¾-inch section of the same kind of pipe forms the gas tank. Wrap a piece of heavy copper wire around one end of the barrel and solder it, if you wish. Setting the barrel aside, obtain the lid of a syrup can for the base and solder the gas tank to it. The gas tank must previously have a section of ¼-inch pipe soldered to it, and a piece of thick brass with a 1/16-inch hole in the center soldered on one end.

Now bend the wire that is attached to the barrel so that it forms a semi-circle on the base and holds the bottom end of the barrel ½ inch from the gas tank. Solder it in place and you have only to make a tip for the burner out of a thin-walled piece of fixture-pipe or other piece of thin brass



A Bunsen Gas Burner Which Is Not Only Cheap and Readily Made from Scrap Parts Found about the Laboratory, but Which Is Also Adjustable.

and allow it to extend 3/16 inch above the barrel. It will probably need a little adjusting to suit the gas you use.

This is done by pulling the tip out a little farther or bending the end of it slightly inward. The distance between the gas tank and the barrel can also be adjusted by bending the heavy copper wire. Once adjusted, it requires no further attention.

Contributed by GEO. J. MELVILL.

CONVERTING TABLE.

The following is an approximate table for changing avoirdupois into metric weights:

Avoirdupois.	Metric.
15 grains	1 gram
50 grains	3 1/3 grams
1 ounce	28½ grams
½ ounce	14 grams
¼ ounce	7 grams

With the above table it is possible to get almost any weight desired.

Contributed by
FREDERICK REYNOLDS.

RADIO DEPARTMENT

The Geltow Radio Station

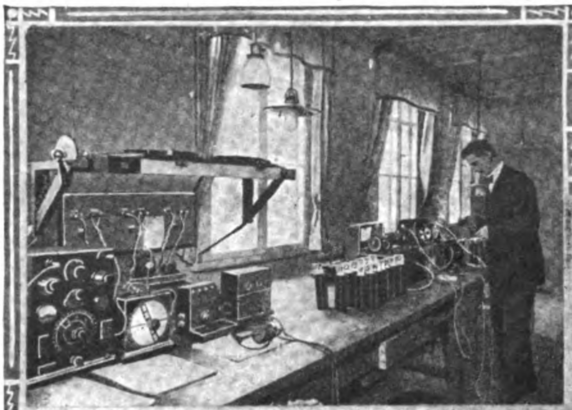
THE two accompanying photographs reproduced herewith show two very interesting views of the German radio tation at Geltow, Brandenburg.

One of the photographs shows the in-:oming radio messages being received and ımplified as well as recorded on a phono-;raph of the wax cylinder type, all ımultaneously. The reader will note the mall loop aerial or antenna in the picture. t is surprising what remarkably large dis-ances can be covered with a small loop or oil aerial such as this when used in con-unction with the new multiple stage audion mplifiers.

Trans-Atlantic messages have been picked ıp by some of the European stations with 'ery small loop antennae, boosting the in-oming signals to the requisite strength vith audion amplifiers.

The second photo shows a more general iew of the interior of the Geltow station. 'he large number of phonograph cylinder ecords containing messages, which have een recorded from distant stations, tell the tory of the work of the station.

One of the principal features of phono-raphic reception of radio messages as ollowed out in this station, lies in the fact ıat messages can be recorded at very high peed—in fact a speed so high as to defy de-:ction or interpretation by regular aural eception. These high-speed messages are fterward translated at a slower speed by unning the phonograph at a slower rate than that employed when recording the signals. The phonograph has found a new rôle in radio station practise today, and serves its purpose particularly well in sending out wireless telephone messages, especially for tests and other specific purposes, where the message is of a fixt and predetermined nature.



View at Left Shows Interior of the Large German Station at Geltow, Brandenburg. At This Station the Incoming Messages Are Put on Phonograph Records, a Number of Which Are Plainly Visible in the Center of the Table.

View at Right Shows One of the Receiving Instrument Tables in the Geltow Radio Station, a Radio Message Being Transcribed from the Phonograph Record by the Operator. The Advantage of the Phonograph in Radio Transmission and Reception Is That the Signals Can Be Recorded at Very High Speed.

Fleet Hears Opera Singer Via Radiophone

Admiral Hugh Rodman in his cabin ›oard the Pacific Fleet flagship U. S. S. *ew Mexico*, is shown in one of the accom-ınying photos, together with his pet dog, istening in" at the wireless telephone, hile pretty Miss Mabelle Burch sang a ›ng from the opera, the young *prima ›nna* being a coloratura-soprano singing ith the Metropolitan Opera Quartette.

Miss Burch has a brother, Carleton Burch, ho sails the seas on the U. S. Submarine F-2. Miss Burch recently asked permission to sing to her brother at sea, by wireless telephone. The request was quickly granted by Admiral Rodman of the Pacific Fleet and an order issued to all the vessels belonging to the fleet to "listen in" on the appointed evening.

Quadrupeds of the canine variety generally do not enjoy music of any kind and give vent to their untoward feelings by their emphatic howls, but Admiral Rodman's pet seems to be enjoying the wireless 'phone opera concert exceedingly. The second photo shows Miss Burch singing into the wireless telephone mouth-piece while the whole Pacific Fleet "listens in."

Those not familiar with the automatic telephone service, which is found in several American cities, will be interested in the type of instrument into which she is singing.

San Francisco has an automatic telephone service similar to that now being made ready for adoption in New York. With the automatic 'phone each subscriber calls his own number and does not obtain the desired party thru a central operator at the exchange. Automatic electrical switchboards operated by electro-magnets and motors effect all of the connections necessary in a few seconds.

As we go to press, a similar radio concert has just been successfully given for the benefit of naval ships within 500 miles of New York City, the soloist having been Mme. Louisa Tetrazzini. Mme Tetrazzini sang from her apartment in the Hotel McAlpin, New York City. Her selections were the "Polonaise" from "Mignon," "Rodono" from "La Sonnambula" in which she sent her high F sharp far out to sea, "Somewhere a Voice is Calling" and "I Milioni d'Arlecchino." After the songs, Mme. Tetrazzini talked with some of the radio men in the Whitehall Building and on the U. S. S. *Pennsylvania*, lying in the Brooklyn Navy Yard.

Miss Mabelle Burch Recently Sang Operatic Selections to the Pacific Fleet via Radio Telephone. Admiral Rodman's Pet Dog Also Enjoyed the Concert.

Locomotive Cab Radio Signal

THE State Railroad Administration of France has made quite extensive experiments with an audible cab signal controlled by Hertzian waves—a "repeater," as the French entitle it—to call the attention of the engineman when he passes a caution signal which is set against him; and the experiments have proven so satisfactory that the government plans to install the apparatus on long sections of its railroads and to equip a large number of locomotives, says a writer in the *Railway Signal Engineer.* This announcement of proposed extensive installations is not yet officially confirmed, but as the system is of interest on its own account and as the experiments have been continued over a series of months, we give herewith a brief description of the apparatus. The installation is on the line running from Paris, southwest, 48 miles, to Chartres. Nearly or quite all of the distant signals between Trappes and Maintenon, on this section, a distance of about 15 miles, are fitted with the wireless system.

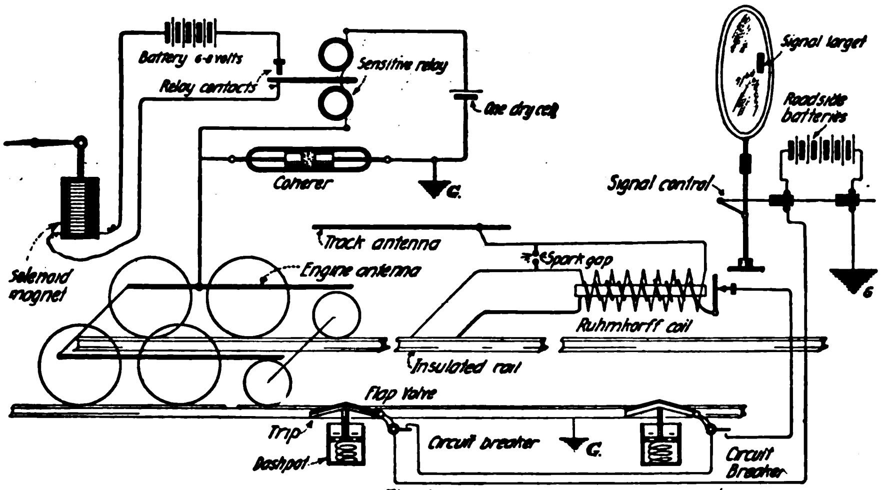


Fig. 1

Diagrams of Wireless Circuits Used Successfully in New French Locomotive Cab Signal Which Is Operated Automatically as the Train Speeds Along. The Coherer and Relay on the Locomotive Operate a Local Circuit Which in Turn Actuates an Audible Cab Signal, Warning the Engineer That He Has Past a Caution or Stop Signal. An Automatic Recorder Attached to the Receiving Circuit Keeps a Record of the Actions of the Engineer so That His Entire Performance Can be Checked Up Upon His Return to the Roundhouse.

The apparatus is the invention of a French engineer, Mr. Augereau, and the essential features are similar to those which were used for wireless communication by aviators during the war. At the roadside station, a Ruhmkorff or spark coil, energized by a small battery and acting by means of a spark gap, produces Hertzian waves which, by acting on a coherer on the locomotive, cause the sounding of a whistle in the cab. The antenna at the station and that on the locomotive are each about 4 feet above the level of the rail, and are of sufficient length, parallel to the track, to act satisfactorily in the case of trains moving at any speed.

The roadside battery is active only when the visual roadside signal is against the train, and only while a train is passing, track instruments being used to give the train this control.

The arrangement of circuits on the locomotive and roadside is illustrated in the diagram. The circuit from the battery energizes the solenoid sufficiently to lift its core whenever the coherer is traversed by the current coming from the antenna. The antenna consists of a copper tube on the side of the locomotive. (In France trains on double-track roads use the left-hand track, and therefore this antenna is on the left side of the engine; but to provide for running locomotives backward, antennae can be mounted on both sides.)

The induction coil at the roadside station, with a primary potential of 8 volts, is capable of producing a spark about one inch long. The secondary coil has one end connected to the ground and the other to a spark gap and to the roadside antenna as shown. This antenna consists of a copper wire about 16 feet long.

The roadside battery has one pole grounded and the other is connected to a wire extending thru the induction coil to an insulated section of rail, as shown. The commutator placed between the battery and the ground is controlled by the visual signal, which makes or breaks the ground connection, the current flowing only when the signal is set against approaching trains. With the signal in the adverse position and the insulated rail grounded (by the presence of wheels upon it), the current from the battery traverses the primary coil; the induced current then leaps the spark gap, and the Hertzian waves are produced and sent out. As before stated, these latter continue only so long as the train is passing a signal.

On the engine, the resistance of the coherer normally opposes the passage of the current from the engine battery, but on passing the roadside antenna, this resistance diminishes and the current then lifts the core of the solenoid. This movement releases a lock, which is enclosed in a box fixed to the side of the speed recorder. This lock controls the valve of the cab-signal whistle (which is mounted in the front of the cab). The blast of the whistle continues until the engineman, by restoring a control lever to normal position, stops it.

A recording stylus is moved by the pushing of a lever to the right, and each operation of the wireless signal is recorded by means of a cam forming a part of the lock, which gives a slight movement of the stylus against the paper tape of the speed recorder. At the end of the run, the inspector at the engine-house finds this record in the form of a short, straight line cutting at right angles the speed record curve. This indicates that the whistle was in working order. When the engineman sees a signal set against him, it is his duty to give the stylus a movement in the other direction and the marks so made, different from those made by the roadside impulse, afford evidence that the engineman was attending to his duty.

Unique Portable Radio Set

Recently under direction of Postmaster General Giesberts in Königsberg the Portophone Service was added to the public utilities of the German Government. Electrical experts agree that this highly efficient instrument is destined to become widely used the world over on account of its practical and portable nature. The present portophone has one stage of radio amplification and two stages of audio amplification; one tube being used both as a radio- and audio-amplification stage. The instrument itself, without the horn, is twelve inches high and ten inches wide. The horn, of course, may be strapt to the case and carried along.

A desirable feature connected with the instrument is that it is simple to operate. The approximate range of the instrument in its present development is about 20 miles, but of course, this will eventually be considerably increased. This photo shows the opening of the Government service in Germany.

New Portable Wireless Telephone Being Tested by the Postmaster General of Germany. The Instrument is Capable of Talking Over a Distance of 20 Miles or More, and is Being Adopted Officially by the German Postal Service.

Girl Receives Election Returns by Radio

Miss Claire Horn "listening in" for the recent presidential election returns at the wireless station installed in the Hamilton Club in the City of Chicago, is shown in the accompanying illustration.

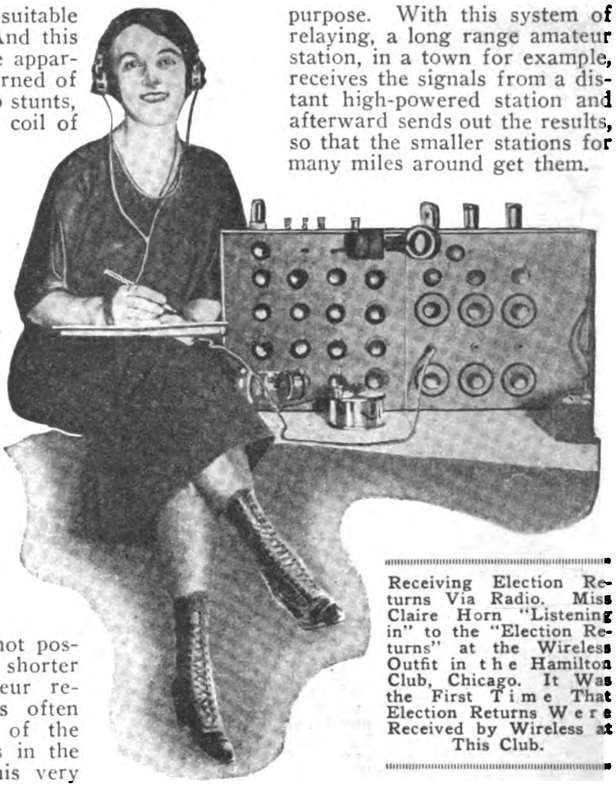
It was the first time that election returns were ever received by radio at this club, and the members found the innovation of unusual interest and convenience.

Thousands of radio amateurs this year, all over the country were listening intently at their radio receivers on election night to intercept the news of the returns as the messages were flashed to the four winds, from powerful radio stations in various parts of the country.

It used to be, and not so many years ago, that we had to wait several days or even several weeks in some parts of the country, to learn the facts about even such important events as a presidential election, and history records that in one of the early American wars, it was at least several days after peace had been declared that one army corps was still without news of this decision on the part of the commanders in chief of the opposing forces, and that this corps kept on fighting viciously, killing thereby many worthy soldiers whose lives could otherwise have been saved.

The time will undoubtedly come and in the very near future, when the speeches of the president-elect and other notables, given on inauguration day at Washington, will be heard broadcast over the country via radio-telephone by practically everyone, who may be equipt with a suitable radio receiving instrument. And this need not be such an elaborate apparatus, for we have recently learned of some remarkable French radio stunts, performed with a loop aerial coil of wire, the same size as a cigar box. With a practical loop antenna of these small dimensions and an audion amplifier, comprising several vacuum bulbs of French type, radio time signals from the Arlington station near Washington, D. C., were picked up at a small radio station in France.

Amateur radio stations have successfully picked up election returns in one of several ways. Those who live within 100 miles or so of large transmitting stations, are quite sure to receive the returns broadcasted by radio from some one of the powerful radio stations operated by commercial companies or by the Navy department. Where this is not possible owing to the relatively shorter range of the average amateur receiving station, the news is often obtained by relaying. One of the largest amateur organizations in the country was founded for this very purpose. With this system of relaying, a long range amateur station, in a town for example, receives the signals from a distant high-powered station and afterward sends out the results, so that the smaller stations for many miles around get them.



Receiving Election Returns Via Radio. Miss Claire Horn "Listening in" to the "Election Returns" at the Wireless Outfit in the Hamilton Club, Chicago. It Was the First Time That Election Returns Were Received by Wireless at This Club.

Turning Book Leaves Tunes Radio

Captain Hyde A. Donisthorpe of London, England, has recently perfected a very ingenious miniature receiving set for wireless telegraphy and telephony in book form, the wave length being varied by opening and shutting the book. Stations of different wave lengths are obtained by opening the book to different degrees; the further the book is opened, the longer the wave lengths and *vice-versa*.

The length of the aerial wire plays, of course, an important part as to the range in wave lengths over which the book will operate, but it has been so designed as to give a range of between 300 and 2,500 meters. Signals in London have been picked up by means of this pocket book from Paris, Berlin, Poldhu, all the local coast stations and ships.

Captain Hyde A. Donisthorpe, of London, England, Has Recently Perfected a Very Ingenious Radio Receiving Set in Book Form, the Wave-Length Being Varied by Opening and Shutting the Book. Stations of Different Wave-Lengths Are Obtained by Opening the Book to Different Degrees, the Further the Book Is Opened the Longer the Wave-Lengths and Vice Versa.

The photograph herewith shows the inventor operating his unique radio apparatus.

The clever pocket size radio set invented by Capt. Donisthorpe brings us face to face with the fact that we are slowly but surely evolving from the realms of large complicated radio receiving cabinets into a new realm of tabloid receiving sets.

Several builders of radio instruments have already shown developments along these lines and we prophesy that within another year or two, practically all of the large six-to eight-foot loading coils, couplers and variometers, so beloved by the radio amateur of today and yesterday, will be relegated to the attic and that in their places we will have highly efficient radio receiving sets, which can be carried in the coat pocket.

The receiving set of tomorrow will approximate in size the average "best seller," or will be of about 7x7x1 inch dimensions and will have tuning inductances wound in the form of multiple-layer honeycomb coils. The variable condensers when used will be made in a very clever and compact manner as hinted at in some of the small radio sets recently brought out both in this country and abroad.

This pocket book radio set puts us in mind of the chap who some years ago contributed a short, witty article to the *Modern Electrics Magazine*, in which he used the coiled springs on his bed for tuning inductances while he pasted sheets of tin-foil on the door and on the wall back of the door, so that when the door was opened and closed, a variable capacity of several odd hundreds of microfarads was attained! The book style of tuner, however, all jokes aside, represents a very neat principle and one which can be very well exploited in popularizing radio sets for the layman.

Articles to Appear in January Issue of "Radio News"

A Complete Portable Set — *By D. R. Clemons*

Comparison of Modulation Methods in Radio Telephony—Part 2 — *By A. S. Blatterman*

A "Phoney" Phone — *By Volney G. Mathison*

A Honeycomb Coil Winding Machine That Works — *By Raymond Roof*

A Simple and Efficient Transmitter — *By Frederick J. Rumford*

Practical Construction of an Amplifying Transformer — *By Robert E. Lacault*

LATEST PATENTS

Phonograph Record-Lifter.

(No. 1,347,548 Issued to Joseph Menchen.)

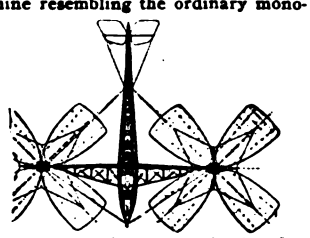
This is a very neat contrivance adaptable to phonographs so as to

automatically lift the records. It consists of a spring attached to a phonograph, to the end of which is fastened a rubber suction cup fitted with an automatic valve. By pressing the cup against the record, a semi-vacuum is created sufficient to raise the record from the turntable of a talking machine. Several types of valves are employed for releasing this record from the lifter, several of which allow for a gradual seepage of air and others which allow air to enter the vacuous space by pressing upon a valve stem.

Revolving Wing Flying Machine.

(No. 1,350,982 Issued to Alexis Beurrier, Edouard Bigourdan & Louis Lacoin.)

This is an improved flying machine resembling the ordinary mono-



planes in the fuselage and other features except that instead of the forward wing or plane, we have two screw propellers having very wide vanes and connected to the engine by means of gears. The axles of these propellers are inclined toward each other. Each screw propeller is so arranged that it can assume various inclinations about its axis. In this manner, the plane itself can be tipt to the right or left, forward or rear. By tipping the wings forward the pull of the plane is exerted slightly in front of its central axis causing the machine to travel forward.

Toothbrush and Paste-Case.

(No. 1,349,110 Issued to William Ogle Snyder.)

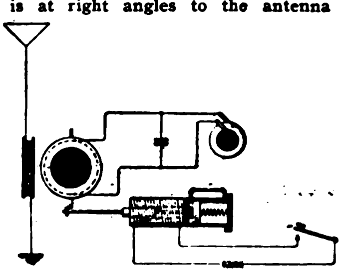
Sometime ago in this magazine under "What to Invent," Mr. Hobson pointed out that a combination tooth brush and paste container was a desideratum. This arrangement is embodied in the present invention.

The toothbrush combination is so arranged that each part is interchangeable. At one extremity is the brush fitted by a cap, the brush being so set that it can be removed at any time and a new unit inserted. The handle is hollow and holds the tooth paste or powder tube and a spool of dental floss.

Radio Telegraphy.

(No. 1,350,801 Issued to John Hays Hammond, Jr.)

This is another of the many patents which Mr. Hammond has taken out on radio-control devices and in this instance it relates to the transmitting station. A high frequency generator is placed in circuit with an inductance coil and in shunt with a condenser. This is placed in apposition with another coil connected to the aerial and ground of the transmitting station. Connected to the inductance first mentioned, is a crank handle coupled to the core of a solenoid, which core is likewise coupled to a dashpot arrangement so that when current is allowed to flow thru the solenoid, its action is then not quick and decisive, but on the contrary, very slow. A spring again brings the solenoid back to the first position. The action of the device is as follows: The generator is sending high frequency currents to the coil but when the key is open and the electromagnet deënergized, the coil is at right angles to the antenna

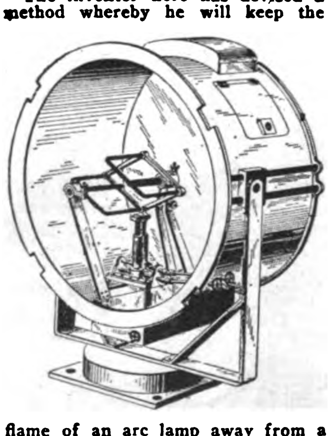


coil and hence, will hardly induce oscillations into the antenna circuit. When the key is prest, the solenoid forces the coil thru a semi-circle, causing it to assume a position parallel to the antenna coil. The effect on a commercial receiving station is very slight, and then only if the receiving apparatus is closely attuned with the transmitting apparatus. In this manner no interference is set up.

Magnetic Deflector for Electric Arcs.

(No. 1,353,693 Issued to John Paley Yorke.)

The inventor here has devised a method whereby he will keep the



flame of an arc lamp away from a portion of the mechanism or from the mirror or lens by the simple use of magnetic deflectors. The magnetic deflectors are so arranged that they are adjustable and are magnetized by an electric current flowing thru them. The invention facilitates the use of arcs in any position so that it is practically possible to obtain stability of the arc regardless of what position the electrodes may be in.

Vision Deflector.

(No. 1,356,498 Issued to William E. Snaman.)

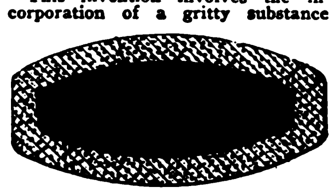
The inventor of this device solves in this manner the problem of pro-

tecting the eyes of the driver of an automobile from the glare of the headlights of the approaching vehicle which of course, would cause a sort of blinding effect; by fitting a piece of colored paper on celluloid to a nose piece or to the cap of the driver, he is enabled to protect one eye from the dazzling lights by simply turning his head slightly. The lights from the approaching car then cause a shadow to be thrown on one eye, but permit of its perfect use in vision.

Poison-Tablet.

(No. 1,349,326 Issued to Charles T. Davis.)

This invention involves the incorporation of a gritty substance

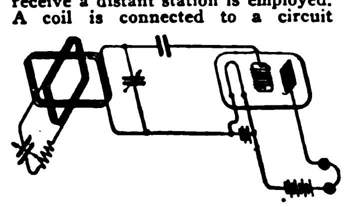


with ordinary antiseptic substances, such as bichlorid of mercury or potassium mercuric iodid, which are highly dangerous when taken internally. In this manner when the tablet is taken an unpleasant sensation is produced by contact of the harsh grit with the tongue or walls of the mouth or with the teeth. The presence of a small amount of gritty substances produces an extremely disagreeable sensation which compels attention and develops a tendency to expel the substance from the mouth.

Radio Receiving System.

(No. 1,350,912 Issued to Ernest F. W. Alexanderson.)

In this invention a method of filtering out, so to speak, of a nearby transmitting station in order to receive a distant station is employed. A coil is connected to a circuit

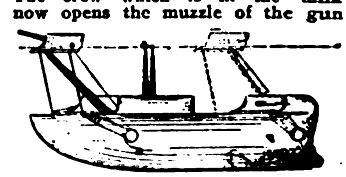


involving the usual vacuum tube, variable condenser, etc., and tuned to the distant station. This coil is in line with the distant station. Another coil at right angles to the first coil is connected to a variable inductance and capacity and is tuned to the local station. In this way, an effective screening is produced, inasmuch as the second coil has no effect upon the first coil and the second coil likewise absorbs energy from the local transmitting station, undesirable currents are not set up in the receiving circuit and it is possible to receive the distant station easily. Such a method makes it possible to transmit and receive messages simultaneously at a given point without locating the receiving apparatus far away from the transmitting apparatus.

Submarine Vessel.

(No. 1,356,294 Issued to Joseph Kuhajda.)

This invention has for one of its main objects, the production of a vessel which may serve for defensive and offensive purposes. It provides the submarine with two gun carrying buoyant tanks. Entrance to the gun carrying tanks is made from the submarine whereupon a collapsible tube allows one of the buoyant tanks to float upward to the surface of the water. Cables are employed for steadying the tank. The crew which is in the tank now opens the muzzle of the gun

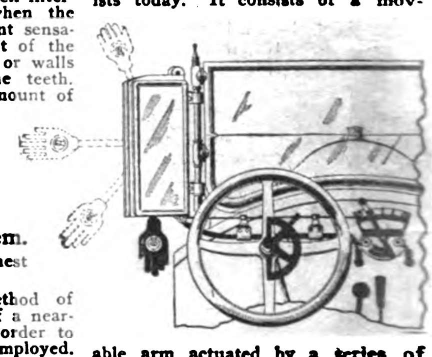


by means of the cable attached to it and can carry on a defensive or offensive warfare while the submarine proper is amply protected because of the fact that it is considerably below the water line. The collapsible tube is extended by comprest air when the air is locked automatically, the tube takes up the recoil due to the firing of the gun.

Automobile Traffic-Signal.

(No. 1,348,367 Issued to Shigeru Masumoto.)

This is another of the many methods of semaphore signaling which are being used by automobilists today. It consists of a mov-



able arm actuated by a series of gears and controlled from a dashboard of the automobile. By pushing a handle to any one of a desired number of locations, the position of the hand of the semaphore is automatically located in a predetermined position to denote a turn. The hand is fitted with a small electric light also controlled from the dashboard, so that it can be illuminated at night. The novel feature of this device lies in the fact that it can be manually controlled, and for that reason the condition of the batteries need not be perfect as is the case with many of the electrically controlled semaphores now employed.

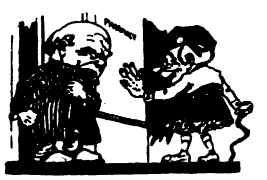
Scientific Humor

A Sad "Reflection."—"I want to see some mirrors."
"Hand mirrors?"
"No; the kind you can see your face in."
—*Dudley Holbrook.*

He Lost Momentum.—"What is the matter with you?" asked the physics professor of a student who had fainted during examination.
"I suppose I had a moment of inertia," answered the young hopeful.—*Felix Kohn.* 10 Rue du Lunain, Paris.

Or—Dead!—A recent sign seen in a feed store reads like this:
"If 'Eggo' don't make your hens lay—they're roosters." —*James E. Harne.*

Cor-Wreckt!—Al. Bert: "How do these love triangles usually end?"
Phil. Bert: "Most of them turn into a wreck-tangle.'"—*John Andersen, Jr.*



Why He Didn't Buy-Carbonate.—"Two penn'orth of bicarbonate of soda for indigestion at this time of the night," cried the infuriated chemist, who had been roused at 2 A. M., "when a glass of hot water would have done just as well!"
"Weel, weel," returned Sandy, hastily; I thank you for the advice, and I'll no' other ye after all. Good night."
—*Max P. Huy.*

What Did the Engineer Slip Him?—A green brakeman was making his first trip up the Sierras. The train was going up a very steep grade, and with unusual difficulty the engineer succeeded in reaching the top. At the station, looking out of his cab, the engineer saw the new brakeman and said with a sigh of relief:
"I tell you what, my lad, we had a hard job to get up there, didn't we?"
"We certainly did," said the brakeman, and if I hadn't put on the brakes, we'd have slipt back."—*Carl A. Fanton.*

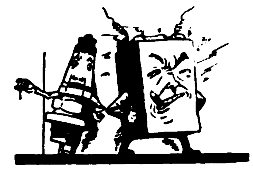
Fine—But Not on the Square.—Farmer Jenkins brought his new flivver into town one day and left it in the public square.

"Hey, there," yelled the traffic cop, "you can't park your car here."
"What you got that sign up for then? Don't it say FINE FOR PARKING AUTOMOBILES?"—*J. A. Poythress, Jr.*

So Would We.—"Daddy, I've got a sentence here I'd like you to punctuate."
This is what Paw-Paw read:
A five dollar bill flew around the corne
He studied it carefully. "Well," he finally said, "I'd simply put a period after it like this."
"I wouldn't," laughed the high-school girl, "I'd make a dash after it!"
—*Ora Krumps*

Did He Wax Enthusiastic?—Doctor: "I will not deceive you, your life hangs on a single thread."
Tailor (feebly): "That will do. If thread's waxed, Doctor, I'll pull thru."
—*Carl A. Fanton.*

FIRST PRIZE $3.00



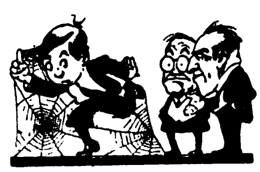
And Tomorrow They'll Do It Again— Spark Plug: "I got fired today."
Battery: "That is nothing, I'm discharged, also."
—*Carl Hawkins*

And Juggles with Figures, Too!—First Student: "A thermometer certainly is a clever instrument to be able to tell temperature so well."
Second Student: "It should be; it has a college education."
First Student: "A college education, how so?"
Second Student: "Well, isn't it graduated with many degrees?"—*Roy H. Cantor.*

How About a Sextette?—Teacher: "Johnny, stand up and tell us how many sexes there are?"
Johnny: "Three."
Teacher: "What are they?"
Johnny: "Male sex, female sex, and insects."—*J. P. Eckersen.*

ALL jokes accepted and publisht here are paid for at the rate of one dollar each, besides the first prize of three dollars for the best joke submitted each month. In the event that two people send in the same joke so as to "tie" for the prize, then the sum of three dollars in cash will be paid to each one.

Meet ...—...y is one of the greatest inventors of the age."
"What did he invent?"
"He invented petrified motion."
—*John B. Moore.*

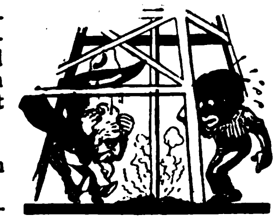


"Step Lively" Would Be Better.—A prison paper back East runs the list of deaths by electrocution under "Current News."—*Morris Kirshner.*

Then the "Lights" Went Out.—The movie-house manager was dying. The nurse and doctor were waiting for the end of the animation.
"Notice the change in features?" said the doctor.
"Features change daily," breathed the dying man while reeling over, as a film covered his eyes and his spirit was released.
—*Sam Elder.*

And Moist From Perspiration.—Prof.: "How can you prove that steam does work in an engine?"
Student: "Because after it pushes the piston, it's tired."
Prof.: "Tired?"
Student: "Sure; isn't it all exhausted?"
—*Roy H. Cantor.*

Well, Well!—'Colonel, I understand your oil well was down 4,000 feet last week."
"Um."
"How far down are they now?"
"Must be getting near the infernal regions—they've struck asbestos!"
—*J. H. Schalek.*



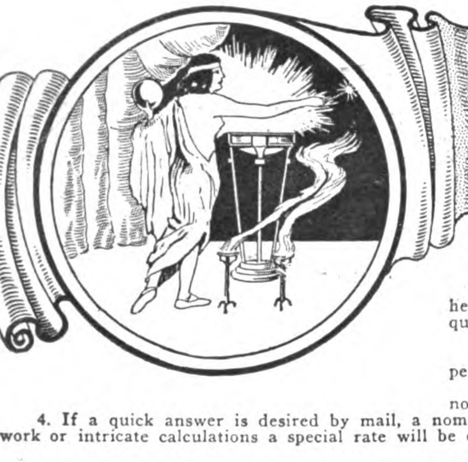
Alas! 'Tis True.—Teacher (to pupil): "What is Science?"
Pupil: "Science is that branch of learning in which one person will prove the reason for a certain thing doing what it does, contrary to popular belief, and then another person will come along and prove it to be different and him to be a liar."
—*C. Willard Duckworth.*

Hope It Isn't a Shooting Star.—He: "Mademoiselle, you are the star of the evening."
She: "You are the first to tell me so."
He: "Then allow me to claim my reward as an astronomer."
She: "How so?"
He: "To give my name to the discovered star."—*Felix Kohn,* Paris.

And Wasn't Patented, either!—A reporter was interviewing Thomas Edison.
"And you, sir," said to the inventor, "made the first talking-machine?"
"No," Edison replied, "the first one was made long before my time—out of a rib."
—*Merit Kirk Burrous.*

They Even Adulterate Vacuums!—We know a chap who received a gross of varicolored electric light bulbs the other day. They were fitted with corks and contained matter of an exceedingly "high voltage."
He was all lit up while the "current" lasted.—... *Hanson.*

Lead Us to Her, Boy!—The other day we heard of a man trying to cross a cow with a mule in order to get milk with a kick in it.—*Franklin Williamson.*



THE ORACLE

The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answer[ed] here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under wh[ich] questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, [no] penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department ca[nnot] be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable resear[ch] work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

Washing Nitro-Glycerine

(1073) C. E. Womble, Raleigh, N. C., inquires:

Q. 1. How to wash nitro-glycerine.

A. 1. Nitro-glycerine when formed, is insoluble in cold water, and hence washing is comparatively a simple operation. It is washed in cold water only, and the colder the better.

Of course, the water should be above 3 or 4 degrees Centigrade, as nitro-glycerine freezes at this temperature. Water can be sprayed into the nitro-glycerine for washing purposes, or the nitro-glycerine poured into water, where repeated changes of water are necessitated.

Removing Stains from Ivory

(1074) Frank Ferrier, Bath Beach, Brooklyn, N. Y., writes:

Q. 1. Please tell me how to remove stains from ivory beads.

A. 1. The beads are moistened and placed upon a tripod over which has been stretched a thin piece of gauze or cheesecloth. This tripod holds **the beads resting upon the gauze membrane a few inches over a vessel containing chlorid of lime moistened with a little hydrochloric acid.**

The entire arrangement is then covered with a bell jar and exposed to direct sunlight. When the ivory objects have been bleached, they are removed and washed in sodium bicarbonate, then rinsed in water and allowed to dry. If not completely bleached when the above process is completed, then apply a paste of whiting and benzol or carbon disulfid, covering the article completely and, after it is dry, rub briskly with chamois or soft wool cloth.

Silver Plating Solution

(1075) H. J. Dritt, Ft. Wayne, Ind., writes the "Oracle":

Q. 1. Kindly give formula for silver plating, using the dipt or *hot bath* process. Either of these methods are satisfactory for plating silverware.

A. 1. In order to silver copper or silver, brass or bronze articles by the hot dip process, you dissolve ten parts of fused silver nitrate in 500 parts of distilled water, and 35 parts of potassium cyanid in 500 parts of distilled water.

Mix both solutions and stir. It is then heated to a temperature of 176 to 194° Fahrenheit in an enameled vessel and the articles introduced, after being well cleansed of fat and other impurities.

Powerful Amplifiers

(1076) L. C. Bundorf, Chicago, Ill., asks:

Q. 1. Several questions concerning amplifiers.

A. 1. The largest sound reproducer and amplifier of telephonic currents is the Magnavox, although this does not mean to state that others may not from time to time be evolved.

With the Rochelle salt crystal, the effect is not an amplification effect, but is simply a transmitter effect. The best amplifier of telephonic currents is some form of vacuum tube, preferably the large size vacuum tube produced for transmission purposes. There does not seem to be any limit of amplification of such currents; this depends entirely on the number of tubes employed in the circuit.

We do not know of any electro-mechanical device capable of giving a higher amplification than the vacuum tube.

Bichromate Battery Query

(1077) J. A. Gerson, Houston, Texas, writes:

Q. 1. Referring to the August issue of your journal, under *Practical Chemical Experiments*, the author states that a bichromate cell can be made by using 710 cu. cm. of water and dissolving in it 80 grams of chromic acid, and then adding 45 cu. cm. of concentrated sulfuric acid. In reference to the 80 grams of chromic acid, there surely must be some mistake, as 80 grams is over two ounces and one-half of same, and chromic acid costs $.65 per ounce, which would make it a very expensive battery.

A. 1. The figures referred to under *Practical Chemical Experiments* were correct. One cu. cm. of water weighs one gram and the usual proportion for chromic acid cells is as above. It is quite true that the cell is expensive, but it is a large size battery, giving a very powerful current for a short time.

When much used the cell becomes saturated with chromium sulfate. In some cases potassium bichromate is used instead of chromic acid, in which case chrome alum is formed, and the chrome alum crystallizes out and sticks so firmly to the bottom of the cell that it is sometimes quite difficult to remove. Potassium bichromate at one time was very cheap, and it will probably come down to the same figure again, when this product is being imported in greater quantity.

ARTICLES WANTED!!!

There is at the present time an excellent opportunity for writers of semi-technical, popular scientific articles and stories, as we are publishing more material of a popular nature each month. Stories should be as snappy as possible and should have well-rounded plots and characters. They should of course revolve around a scientific, elec-

noticeable or produced unless the current is of decidedly too high an amperage for the electro-magnets which happen to be used on the relay. Direct current is invariably used on all polarized relays. It is possible to use alternating current on a relay without the least sign of "chattering," as described in the May, 1920, issue of the Electrical Experimenter, on page 39, where Mr. Donald McNicol describes his arrangements for using A.C. on the D.C. relay in a perfectly satisfactory manner.

Q. 2. Are selenium cells reliable and do they deteriorate with use? Where can selenium cells be obtained and about what is their approximate price? Does a selenium cell operate the same on alternating current as it does on direct curre[nt]? Is a selenium cell sensitive to different intensit[ies] of light?

A. 2. Selenium cells are reliable for a certai[n] period of time, but they deteriorate with age an[d] also become more sluggish usually after a certai[n] period, say a month or two. There is somethin[g] new, however, in photo-electric cells which is ver[y] constant in its action and it is called the "Cas[e] *photo-electric cell.*" Selenium cells can be obtain[ed] from various supply houses advertising in th[is] journal. We have never used selenium cells o[n] alternating current and cannot say much abo[ut] their behavior in this way, but we presume th[at] they can be used in such a fashion with th[e] proper form of circuit, with suitable condense[rs] to smooth out the current, etc. A selenium ce[ll] is sensitive in proportion to the amount of lig[ht] thrown on it, and the stronger the light, th[e] greater the ratio between its light and dark re[]sistance.

Plastic Compound Formula

(1079) Mr. E. L. Behrens, Waukesha, Wis., asks:

Q. 1. For a plastic compound suitable for molding knobs, condensers, handles, etc.

A. 1. We give herewith a compound which may be molded and which is plastic.

Glue is dissolved and boiled. To this tissu[e] paper is added which readily goes to pieces. Some chalk is steered into the mixture and linseed oi[l] added. This should form a thick dough. It i[s] kneedable between the fingers and can be pres[t] into molds. It becomes as hard as stone and ver[y] firm.

Battery Charging Resistance

(1080) James Tompkins, Staten Island, N. Y., asks the Oracle:

Q. 1. How to compute the necessary resistance to effect a given drop in voltage for re-charging storage batteries or operating low voltage charge[s] from 110 volt D.C. lighting circuit.

To answer the above question, the resistance within whose limits the potential desired is to be expended, must be known; or, what follows fro[m] the above, the desired current—otherwise, no answer is possible. Then in series with the above resistance, place a second resistance equal to 110 minus the desired voltage multiplied by the first resistance and divided by the desired voltage.

Suppose you want a potential drop of 8 volts within a resistance of 2 ohms: 110 minus 8 gives 102; 102 multiplied by 2 gives 204; 204 divided by 8 gives 25½ ohms; this is the resistance to be put in series with your resistance.

Or do the same thing this way. Divide the desired potential which we assume to be 8 volts, by the resistance of your appliance, assumed to be 2 ohms. This gives 4 amperes for the current. Divide the total voltage 110 by the current 4—this gives the total resistance which is 110 divided by 4, giving 27½ ohms. Subtract the resistance of your appliance from this and 25½ ohms are left. This is the resistance to be put in series with your resistance, which is 2 ohms, as stated above.

The general idea is to connect the two points between which the 110 volts difference of potential is maintained, with a resistance, the capacity of whose conducting wire must be enough to carry the current without undue heating. Then by tapping the resistance, voltage or potential difference may be obtained, exactly in the proportion of the resistance tapt to the total resistance. It is therefore necessary to know what current you wish to have before the calculation can be made.

Bench Drill from Pipe Fittings

By R. E. NELSON

(*Continued from page 993*)

Drive the shaft in place in the pulleys and using the shaft as an arbor, true the outside diameters of the pulleys and face the sides off in a lathe.

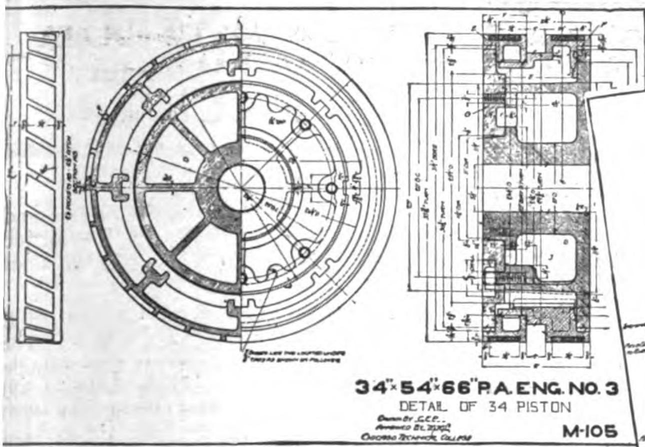
If different spindle speeds are desired it will be necessary to change the sizes. The pulleys shown in the drawings give spindle speeds of approximately 2300, 1400 and 840 R. P. M. when the motor runs at 1750 R. P. M. I purchased a ¼ H. P. washing machine motor which came equipt with a 2" grooved pulley and I did not alter the size of this.

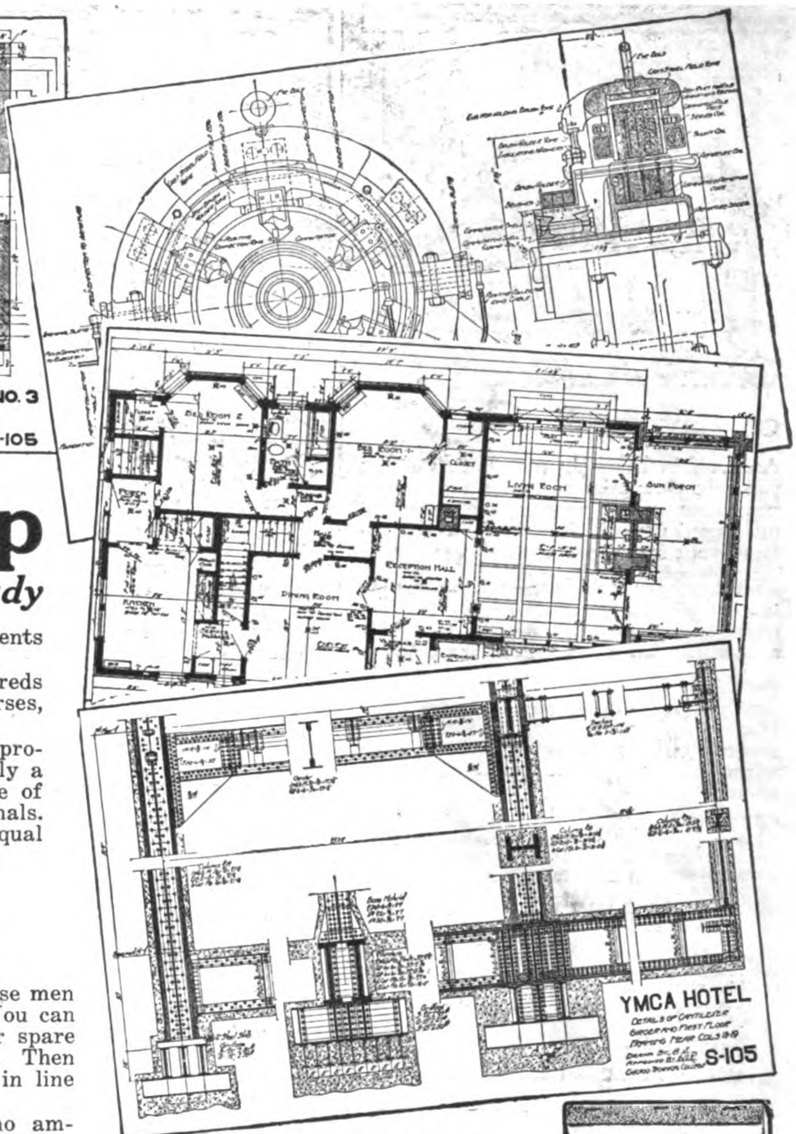
The easiest method of supporting the shaft "T" is to make two bearings from cast babbitt, one as shown at "S," figures 2 and 3, to fit around the main column "Z"; and the other in the shape of a small pillow block as shown at "W," which can be mounted on a wooden block of the proper height. Oil holes should be drilled in the top of each bearing, or else oil cups should be fitted to properly lubricate the shaft.

Babbitting Spindle Bearing.

After these parts have been completed the next step is to babbitt the spindle bearings. This requires very careful work as the accuracy of the drill depends upon it. First bolt the frame to the base board. Next cut four pieces about 2½" x 2½" out of 1" soft pine. With an expansion bit bore a hole *one half* of the way thru each piece of such a size that the ends of the tees "C" and "C'" will just fit snugly in the holes. With a ½" bit bore a hole the rest of the way thru the blocks. Fit one block on the top and bottom of each tee and then push the spindle thru these holes. After the spindle has been lined up cut a pouring lip on the top block of each tee, or, if the builder desires it, the top block on each tee may be left off entirely and the lower block on each tee relied upon to hold the spindle in alignment. Before pouring the babbitt be sure to plug the nipples "N" and "N'" with something (clay or putty), to prevent the babbitt from running down in the frame. Both bearings should be poured at the same time to prevent the spindle from springing or warping. A little white lead smeared on the spindle will prevent the babbitt from sticking to it. When the metal is cool drive out the spindle and polish it up. If the bearings are tight turn the spindle by hand using plenty of oil until they loosen up. Cut oil grooves in each bearing and drill an oil hole at the top of each tee and fit an oil cup.

The final step is to assemble all of these parts and give the drill a trial run. Whether or not the spindle runs true and free from wobble depends upon the workmanship as a whole. In conclusion it may be well to state just what may be expected of the drill. The writer is using a drill as described for the usual run of light work and it is giving fine service. It will drill a 5/16" hole in soft steel with ease, and when working in fibre and softer materials a ½" hole can easily be drilled.





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The Limitations of Sight

By WILLIAM M. BUTTERFIELD

(*Continued from page* 976)

scope as shown in our illustration this is provided for, by light reflected up from a mirror thru the object and around it, as it rests on the stage of the microscope. The general principle of the microscope and astronomical telescope are identical. Each of them produces a focal image within the tube of the instrument by the action of the lens or lenses at the lower or outer end of the instrument. These lenses are the objectives. By a more or less complicated eye-piece, this image is then magnified for its reception by the human eye. The Galilean telescope, represented by the opera glasses of today, operating on a different principle, produces no focal image within the barrel of the instrument, but transmits the rays from an object to the eye at a greater angle of convergence. But as said before, its action resolves itself into the securing of a better angle of incidence for the rays of light upon the lens of the eye, so as to increase the size of the focal image of the object on the retina.

Photography indirectly increases the range of the eye in telescopic work, because stars absolutely invisible to an observer at a telescope will affect a photographic plate occupying the place of the observer's eye, if a long enough exposure is given.

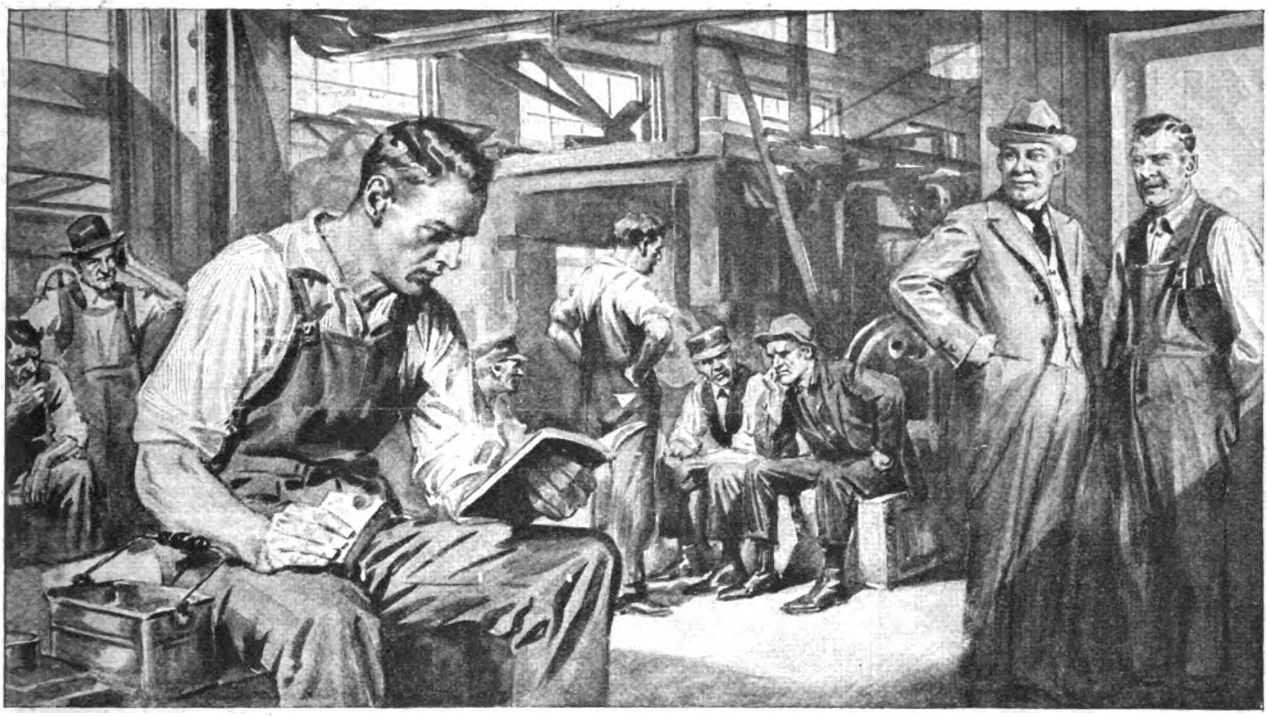
The photographic plate is much more sensitive to rapid changes in light and also infinitely more sensitive to very faint lights and lights at both extremes of the spectrum. Thus, an ultra-violet light which has no effect whatsoever on the retina will nevertheless affect a photographic plate and quite interesting landscapes can be taken under the influence of either ultra-violet or infra-red rays, even at night.

The photographic plate also seems to have the property of allowing light to accumulate sufficiently upon one spot or cause a decided change in the chemical coating upon that plate. For that reason, many stars have been discovered in the heavens by means of the photographic telescope which had escaped even the trained eye of keen observers, and many hitherto ultra-microscopic objects have been photographed because of the fact that they refract or absorb rays of ultra-violet light. The bacillus which caused the recent epidemic of influenza-pneumonia was claimed to have been discovered in this manner.

Home Mechanics

(*Continued from page* 989)

hollow it out by boring first with a bit, then cutting away the wood between the holes, as shown in the top drawing. Oval or squared openings with round corners can be obtained in this way. The base and bottom is also in one piece, with its holes for the pins bored thru those in the box—to make them match. Those in the top are bored only half thru the wood, but bored also with the bit passing thru the holes in the box as before. To prevent splitting when the bit breaks thru the opposite surface, let the screw of the bit only come thru, then reverse and finish the hole from the unbored side. Three screws may be used in holding the bottom more securely, as well as the pins, if desired. The boxes are stained, varnished or painted in the manner desired.



Wonderful Experiments In High Pressure

(*Continued from page* 966)

Phosphorus gave two new forms under pressure. One was a new modification of white phosphorus obtained at high pressures and moderate temperatures. On release of pressure the new white phosphorus changes back to ordinary white phosphorus. With higher temperatures and pressure, *black phosphorus* was produced. The transition required from five to thirty minutes. On release of pressure, black phosphorus does *not* change back to white phosphorus. The black phosphorus is of much smaller volume than the original white phosphorus. It is not definitely a compound, and it seems to be impossible to produce it from red phosphorus.

The specific gravity of black phosphorus is 2.691 as compared with 1.83 for ordinary white phosphorus. It is quite hard to ignite it; it is almost if not entirely stable in the air, and it is a fairly good conductor of electricity. White and red phosphorus are almost perfect non-conductors.

The electrical resistance of metals except for antimony and bismuth was found to decrease with pressure.

The Making of Copper Articles by Electrolysis

By SAMUEL WEIN

(*Continued from page* 985)

saturated solution of copper sulfate, and sufficient amount of sulfuric acid. The best results are had with the solution advocated in Bulletin No. 52 and issued by the Bureau of Standards. This consists of:

Copper Sulfate.............	27 ounces
Sulfuric Acid...............	11 ounces
Water	1 gallon

The specific gravity of this solution is 18 degrees Baumé. It is advisable in preparing the solution to stir it well and then to allow it to stand until perfectly cold when it will be ready for use.

The best results are had with a current density of about 18 amperes per square foot, and 1½ volts at the beginning of the electro-deposition; this is maintained for about three hours, after which the voltage is reduced to about 1 volt and kept at this potential until the completion of the 24 to 36 hours, or until the desired thickness of deposit has been obtained.

It is interesting to note that an increase in the amount of copper sulfate or of the sulfuric acid will slightly increase the tensile strength of the deposited copper.

Such compounds as gelatine, glue and tannic acid in the proportions of one part to one thousand of acid copper-sulfate electrolyte, will give a fine grained tenacious deposit under the usual conditions of plating. The effect is more marked if the electrolyte is slightly warmed to 25 or 35 degrees centigrade.

The deposition of copper is very even and homogeneous, but for practical purposes, it is somewhat too slow. It is for this reason that the solution is made hot (by steam pipes laid on the bottom of the tank) and is subjected to agitation. There are several ways of agitating the solution; these are by blowing compress air thru it, by revolving the cathode in a horizontal, vertical or in an inclined position, or by mechanically stirring the liquid. This permits the use of a greater current density in the electrolyte.

By increasing the temperature above the normal, the tensile strength will decrease.

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Telegraphing Photos by Code

(*Continued from page 967*)

at the office of the *Daily Express*, each of which constituted the make-up for one of the celebrities aforementioned.

It is claimed that Mr. Andersen uses a special apparatus for translating the cablegrams and reconstructing the picture therefrom, which instrument and method has to be employed in a photographic dark room. The details of the Andersen system have not been given out yet, but he is frank to say that it is unlike any of the previous systems of transmitting photographs or photo-diagrams based on the employment of numbered or lettered squares,—such as the Leishman method which has been in use for some time between New York and Denver for transmitting photographs of the newest happenings.

One thing is known with reference to the Andersen system and that is that the original photograph or sketch has first to be accentuated by an artist, so as to represent a decided contrast between light and shade. The elements of this method, as far as known at present, can be gleaned further by inspection of Figs. 1, 2 and 3.

Fig. 1 shows a half-tone or photograph of a woman's face, while Fig. 2 shows the artist's or draftsman's line cut accentuation of the same picture, preparatory to its transmission by code.

Now it becomes an easy matter with a suitably divided and numbered scale to code such a picture so that it can be sent by telegraph, telephone or radio in the usual manner, to practically any distance desired. Fig. 3 shows a simple scale which the student of such subjects may like to reconstruct, and this of course should be made of celluloid such as used in making animated movies. It may be divided by vertical and horizontal lines drawn with India ink and a draftsman's ruling pen in the manner indicated, and the horizontal lines or abscissæ lettered A, B, C, while the vertical ordinates may be numbered 1, 2, 3, 4.

When this scale is placed over the line cut or accentuated photograph representing the line cut, it becomes a comparatively simple matter to write a code message such as that given in the illustration, Fig. 4, whereby a person receiving the code message can, with a small scale and a piece of thin tracing paper placed over it, reconstruct the picture line for line. An improvement over the method of simply placing a piece of thin tracing paper over the scale, would be to place the scale and paper over a piece of glass and provide an electric light behind it, which should make the drawing or picture more accurate and visible.

It will be at once perceived, of course, that any method of this nature, whether it uses numbered squares or some other scheme, is practically always limited in its accuracy or reproduction of the picture by the size of the squares,—the smaller the squares or the finer the lines forming the squares shown here for an illustrative example, the more accurate the products will be, and the larger the squares for a given size picture, the cruder the results obtained in the reproduction will appear.

It is said that the cablegram used in transmitting Miss Vanbrugh's photo contained but 145 words, while King George's photograph required 185 words.

The apparatus is said to be simple and of low first cost, and the system worked out by Andersen can be taught to anyone in a short time, so he says.

"So long as the code words are accurately transmitted," states Mr. Andersen, "there is no doubt about the exact reproduction of the photograph."

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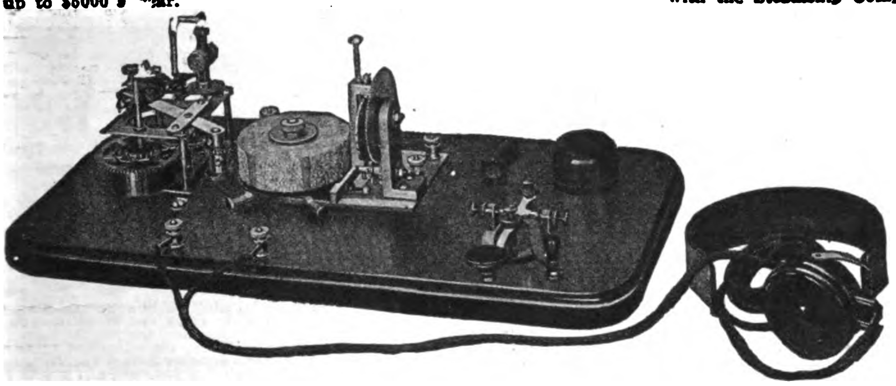

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Science and the Weather Man

(*Continued from page 969*)

bottom and a small tubulure at the center so that the water *falling within the collector is conducted to a point directly over the center of the tipping-bucket bearings.* See photo and diagram.

The *tipping bucket* and a portion of the frame are shown in figure. A central partition, indicated by dotted lines in the drawing, divides the bucket into two *equal* compartments. The trunnions forming the axis upon which the bucket tips are placed below its center of gravity. In either position of the bucket, one or the other of the compartments will receive and retain the water delivered thru the funnel of the collector.

The weight of the bucket and the position of its center of gravity have been so adjusted in relation to its supports that when one of the compartments has been filled with the quantity of water representing one-hundredth of an inch of rain in the 12-inch gage, the bucket tips upon its bearings, emptying the water from one compartment, and at the same moment presenting the other compartment to receive the incoming water. The water thus delivered from the buckets is retained in the reservoir section for subsequent measurement in bulk. The apparatus recording the tippings of the bucket is attached to the so-called triple register. The record sheet upon this instrument moves at a relatively rapid rate by clockwork. Nevertheless, in order to render the registration of the most rapid rates of rainfall legible, the recording pen traces its record in a zigzag line of steps, each step represents one-hundredth of an inch of rain, and one complete zigzag comprises ten steps. In the majority of cases the individual steps are perfectly legible, but in records of very rapid rates each individual step cannot always be discerned. The points of the zigzag, however, are separated by ten tips or steps, and are distinguishable under even the most rapid rates.

THE ROLE OF THE BAROMETER IN WEATHER FORECASTING.

Possibly one of the least understood phases of weather reports and weather forecasting, are the terms *high and low pressure areas,* as shown on the weather maps gotten out daily by the Weather Bureau and posted in public places; and also the interpretation of high and low barometer and barograph readings. We are indebted to Dr. James H. Scarr, meteorologist in charge, New York branch of the U. S. Weather Bureau.

In many public places, hotels, restaurants, clubs, etc., there are placed barographs which record continuously on a revolving paper covered drum, the barometric pressure at that locality, so that those interested may, by keeping in mind the following principles, and a daily reference to the "Weather Map," form an enlightened opinion of the relative position of the locality of the observer to the general conditions prevailing over his section of the country. He may note the slow or rapid progress of these conditions, and supplement the daily weather forecast with "up to the minute" information.

In the latitude of most of the United States and the southern portions of Canada, the march of weather conditions is from west to east. Waves of high and low pressure (Barometer) follow each other alternately across the continent in pretty regular succession like the waves of the ocean influenced by a west wind. The crests of these waves are the "highs" and he troughs are the "lows." The space be-ween the crests of two successive waves s on the average about three days. The verage forward or eastward movement f the wave crest varies from some two undred to five hundred miles in each 24 ours in summer, to twice that amount in vinter. Both these elements of extent nd movement vary greatly in all seasons.

At the surface the greater pressure weight) of the mass of atmosphere under ne crest of the wave causes the air (wind) › flow toward the trough of the wave here the pressure is least.

Owing to the earth's rotation, these winds aused by differences in pressure are de-ected toward the right, and set up great hirls or depressions, making the trough f the wave much lower in some places ian in others. These produce the more less elliptical form of the surface isobars lines of equal pressure), and the term cyclone" is applied to such a depression is also called a "center of disturbance."

These "depressions" tend to destroy the mmetrical appearance of the pressure aves at the surface; but at elevations of),000 feet most of the closed or circu-r isobars disappear, and the true sym-etrical wave motion is apparent.

Now take a cross-section of the atmos-iere from east to west. Remember we e not riding on *top* of these atmospheric aves, but are standing on the solid bot-m of this relatively shallow ocean of r, and just slightly west of the crest a great wave. Our barograph trace is reached the highest point and is start-g down its westward slope. This slope just beginning to *us*, but it has been oing on to the west of us for two or ree days—possibly a week or more—grad-lly drawing nearer till now the crest this particular wave has past overhead. he wind is moving westward (an east ind) toward the trough of lower pres-re, gradually increasing in velocity and rning more and more to the right. All e time the air as it approached the low-part of the trough and met with the st winds moving eastward from under e crest of the next wave to the west, se, being forced upward by the greater essure on either side. By the time these nds reach the center of the trough or pression, those from the east have turned far to the right that they are moving rth (south winds); while those from e west are now moving south (north nds). This is really the chief cause of e more or less circular "depressions" of e low pressure trough at the surface.

Now south winds are warmer and for it reason have a greater capacity for isture than north winds. These winds different temperatures and moisture con-it (humidity) swing slowly round and and in a whirl mixing and forming uds as they rise to higher elevations d lower temperature. Most of this cloud ss is pushed off to the east of the dis-bance trough by the west winds of h velocity which are nearly constant at h elevations. Rain, snow, sleet, hail recipitation) are formed in this cloud ss which sometimes extends over the ire western slope of the retreating wave st which has just past us.

Perhaps before the crest past and our ometer began to fall, long cirrus stream-of white fleecy clouds (mare's tails) be-to overspread the sky from the west southwest. The rate of the fall in ssure (barometric gradient) depends on depth of the depression below the crest the wave and the rate at which it is ving. The center of depression itself y be getting deeper as it advances. is is usually the case in severe storms ere the rotary movement of the winds the center is rapid, and the uprush of is correspondingly greater The dis-ce of the observer, therefore from the ter of the trough, or the rate of its approach are mere conjecture unless the development of the disturbance has been observed before it began to have any effect on our barometer. But with the weather maps of yesterday and the day before, we may form fairly accurate short-range conclusions from observing its action.

If, for instance the storm (disturbance) center yesterday morning was in the vicinity of Chicago, and this morning in the vicinity of Erie, the continued projection of that course will cause the center of the path to lie thru southern or central New England.

Now by projecting the point of observation westward parallel to the projection of the storm track, we can estimate with reasonable accuracy just what relation or position we will sustain with reference to the storm center at any given time within the next 24 to 36 hours. An occasional reference to the barometer will disclose whether or not such projection and prognostication is being fulfilled.

When our barometer has reached its lowest point and begins steadily to rise, we may be sure that the storm center has past our latitude, and that we are passing under the next advancing wave of higher pressure to experience conditions generally prevailing in those portions of the country already under the influence of this condition of rising barometer. This change will almost invariably be accompanied by a shift of wind from easterly to westerly, with clearing and cooler weather.

The order of the wind shift will depend on the position of the observer with reference to being north or south of the path of the disturbance center.

If the path lies to the north of the observer the wind will shift through south, southwest, and to northwest, and the change to colder will be somewhat gradual.

If, on the other hand, the path of the disturbance center is to the south of the observer, the wind will back quickly thru north to northwest, and the change in temperature will be greater and more abrupt.

It may be inferred from the foregoing that the presence or absence of water vapor in the air is not the thing that appreciably affects the rise or fall of the barometer. Air and water vapor, like all other gases, occupy space practically independent of each other. A given space at a given pressure and temperature will absorb or be saturated with a given amount of water in the form of vapor, regardless of whether the same space contains air or other gases or only ether. It follows then, that when space is filled with one gas (say air), and another gas (say water vapor) is injected into it, the weight of the contents is the combined weight of both gases. Water vapor is, as a gas, lighter than air, but a cubic foot of dry air weighs more than when water vapor is associated with it. So, then, it is not moist or dry air that causes either high or low barometric pressure. Rather the moisture or dryness of air is the result of changes in the position, or elevation of masses of air, as a result of differences in pressure. Of course it also depends on the nearness or remoteness of a plentiful supply of water surface from which air in passing becomes more or less humid.

Moderately warm air with a moderate relative humidity at the surface, will be reduced to saturation and precipitation if forced high enough to cool it below the "dew point." If all air currents (winds) were parallel to the surface, there would probably be almost no precipitation except where the air was forced upward over mountain ranges. But fortunately, due to differences of temperature and pressure, air is forced upward or downward as well as laterally, and thereby undergoes the changes necessary to produce condensation and precipitation of its moisture.

Perpetual Motion Prize Winner

(*Continued from page* 995)

Third Honorable Mention.

In your October issue you publish Mr. A. d'Abro's criticism of Mr. Burgin's explanation of why rubber cylinders, with top and bottom rigid walls, one weighted and free to move, would not work if attached to an endless belt passing around wheels arranged one above the other. Mr. Burgin said the bouyancy (weight) would be the same on either (sic) side. Mr. d'Abro says this is incorrect, because: (a) when the weight is on top and compresses the air, the sides will bulge (which is correct); but when the cylinder is inverted and the weight pulls downwardly, the cylinder is lengthened, which would "increase the volume of air and decrease its pressure."

This is wrong. Pray tell us where he gets additional air to increase its volume. The air is attenuated or rarefied and its pressure is decreased. Again, he says that the weight is balanced or reaches a state of equilibrium when "the interior push on the bottom of the cylinder will be equal to the atmospheric push" (outside pressure, 15 pounds per square inch) "on the bottom, minus the weight, thus the interior pressure is reduced." Ye gods! what illogic. What becomes of the sustaining support of the rubber cylinder? When ever did a "minus" pressure equal zero, or atmospheric pressure?

In Mr. d'Abro's suggested modifications his false physical assumptions are again paraded as facts. Instead of rubber pockets he proposes two metal cylinders, equidistantly placed on an endless belt running over and under two wheels, in vertical alignment, immersed in water up to the center of the shaft of the upper wheel. The cylinders are open at one end and contain movable weighted pistons which move "without friction" (a mechanical impossibility) in the cylinders, but can't escape. The cylinders contain no air, and at starting the pistons are at the bottoms of the cylinders. The piston in the inverted cylinder slides down (a practical impossibility in the presence of a supposed perfect vacuum), but he says it does, anyway, so we will let it go at that. In any event, "to obtain this result," he says, "it will be necessary for the weight to be of sufficient magnitude to overcome the cumulative effect of the atmospheric pressure, plus the hydrostatic pressure—theoretically at least, this is possible." If the cylinder is immersed, where, oh, where, does he get his "atmospheric pressure"? Answer: Probably from the same place that he got it to increase the "volume" in his stretched rubber cylinder—his imagination. His hydrostatic pressure is there, and depending upon the depth of submergence, is exerting an upward pressure on his "frictionless" piston, assisted by the vacuum exerting an upward pull of 15 pounds per square inch. But we must not say this. We must violate all physical laws and the laws of nature and assume that the weight moves down. What if it does? A vacuum is nothing, it is the absence of all matter, possessing neither weight nor any other property. But we shall invest our vacuum with the property of buoyancy, a relative term, because we must stick to our false assumption and displace some of the water, as well as our faith in the laws of nature, permitting our expanded chamber to rise until it floats—and stops. Unfortunately, we do not have frictionless bearings for our shafts, nor frictionless belts, nor frictionless anything that moves except the pistons in our cylinders, and even these together with the whole mechanical abortion, will stop when they reach a state of equilibrium.

F. R. CORNWALL.

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[EDITOR'S NOTE:—A complete vacuum back of the piston will not prevent its movement to the outer end of the cylinder, if a force exceeding 14.7 (about) pounds to the square inch of its area is exerted upon it. A vessel, with a perfect vacuum maintained in it, will be more buoyant than if full of air. Any object or vessel immersed in open water is subjected to atmospheric pressure.]

Fourth Honorable Mention

Before the piston can exert the necessary pressure on the water it must first be lifted to such position that the piston will slide, and this takes more than the available motive power, which will be understood when we remember, that no body can give out energy unless that energy has first been stored into it by a force of sufficient magnitude to do the work that is expected from the first body; so if we observe the work to be done and the available energy to do it, we see at once that there is a point in the cycle, where both sides of the apparatus are balanced, where the opposing force equals the motive force. Searching for perpetual motion, therefore, is comparable to the man trying to life himself from the ground by his boot-straps.

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Practical Chemical Experiments

(Continued from page 990)

alloy of the same metals as solder. One important fact about solder is its low melting point. It is lower than that of lead alone and can therefore be used in making a lead joint. If pure melted lead were used the object to be soldered would itself be melted.

Preparation of Type Metal

When we stop to consider the multitude of books, magazines and newspapers that must be printed from type we see the importance of having some metal substance that will not only be durable, but will also give type with clear-cut definite edges. No single metal, that will readily fuse, answers these requirements. Either the metal is too soft or in solidifying in the mould it contracts and gives type with rounded edges. It was found that if antimony and tin were added to lead an alloy resulted which was not only hard but on solidifying actually expanded instead of contracting. This solved the problem and gave type with firm definite outlines.

To make the alloy, using the same apparatus as before, melt together 75 grams of lead, 20 grams of antimony and 5 grams of tin. Also mold this into sticks. (See Fig. 2.)

It will be found interesting to start a chemical museum and these alloys might well be its nucleus. Obtain some small specimen tubes for holding them and place a neat label on the outside of each. (See Fig. 2.)

An Alloy That Melts in Hot Water

This alloy is called Wood's Metal and sometimes with a slightly different composition Rose's Metal. For many years it was only a curiosity, but with the coming of automatic fire extinguishers of the sprinkling type this alloy became of great importance. The perforations in the sprinkling pipes which lead thru the building are filled with plugs of this alloy. Then if fire breaks out at night or at any other time these little plugs melt out at temperatures far below the kindling points of the surrounding objects, which are so thoroly wet down that they will not take fire. Fire which has actually started is also extinguished.

One such alloy is made by melting together 80 grams of bismuth, 40 grams of lead, 20 grams of tin and 15 grams of cadmium. Bismuth is a heavy silvery white metal and the low melting point is due chiefly to its presence.

After you have made some of this alloy place a beaker of water over a Bunsen burner and raise the temperature until a thermometer indicates about 60 degrees C. Then introduce a stick of the metal and you will find that it melts off and dropping to the bottom runs about like mercury. You may find it necessary to raise the temperature a little above 60 degrees, but in any case the alloy will melt far below the temperature of boiling water. (See Fig. 3.)

Another application of these low melting point alloys is to be found in fuse wire used as a protection against the overloading of an electric circuit. Such wire consists chiefly of lead and tin, and it can be made with great accuracy to melt at a certain definite number of amperes. If you have no means of drawing wire it will be impossible for you to prepare fuse wire.

Babbitt's Metal

This is one of the most useful and widely known of the common alloys. It is called an *anti-friction* alloy and is used for journal bearings. Molten mixtures of metals do not always solidify into a perfectly uniform mass, but such a condition is desirable in an anti-friction alloy. What is wanted is a soft mass but one containing hard particles. The hard particles bear most of the pressure but, as the alloy wears, they are prest into the soft matrix, so that a smooth surface is always presented.

To make such an alloy melt together 3 grams of antimony, 4 grams of arsenic, 9 grams of zinc, 5 grams of lead and 19 grams of tin. In many of these anti-friction bearings copper is also present.

Lead Shot

It was early found that lead alone was too soft for the best projectiles. Therefore, something must be found which, by being alloyed with it, would increase its hardness. As a result of the search it was discovered that a very small quantity of arsenic would give the required degree of hardness.

In preparing this alloy melt 100 grams of lead and then sift into it one-half gram of arsenic. When it has cooled test the hardness of some of the original lead and that of the alloy by trying to cut them with a knife blade.

Preparation of Bronze

For the preparation of bronze a considerably higher temperature than that possible with the Bunsen burner will be required. Either you must have a forced draft or some type of electric furnace. If you have access to a country blacksmith shop, undoubtedly you can obtain the necessary temperature by using the bellows and forge. I once had a gas furnace connected to a chimney giving a 20-foot draft which would melt copper. This means, however, a temperature of nearly 1,100 degrees Centigrade or about 2,000 degrees Fahrenheit. Either the electric arc furnace or the resistance crucible furnace described in the November issue will be found very useful in this work. The resistance furnace is best but cannot be so easily made and costs more if you buy it.

Bronze as originally made contained only copper and tin, but the bronze of today has zinc as a constituent.

In preparing the alloy weigh out 75 grams of copper, 15 grams of zinc and 10 grams of tin. Do not add the zinc and tin until the copper has been melted. Place the crucible with the copper in the furnace and cover tightly with the lid. With the furnace at full heat it will require about 20 minutes probably to melt the copper. As you remove the cover occasionally to observe the process it will seem as if the white-hot copper will absolutely resist the tremendous heat and refuse to melt. But it cannot fuse until its melting point has been reached, however much it may seem as tho it ought to succumb to this onslaught of heat energy. Finally, tho, as you take another look, you will see the copper changed into a lake of molten metal as clear and limpid as water in a cup. Then add the zinc and tin and after they have have had time to mix, which will require only a few moments, remove the crucible with a pair of long tongs and immediately plunge it beneath the surface of water in a pail ready at hand. (See Fig. 4.)

Once in carrying out this operation I used, instead of a pail, a large battery jar. Immediately, however, upon immersing the crucible and contents a terrific explosion occurred and the battery jar was blown to fragments. The crucible, too, was shattered and the bronze was reduced to a fine sand.

Preparation of Brass

Brass may be prepared in exactly the same way as bronze. It consists of 70 parts by weight of copper to 30 parts of zinc.

After you have prepared some brass chip off a little piece and dissolve it in nitric acid. A blue color will at once appear showing the presence of copper, which may be intensified by the addition of an excess of ammonia solution. This shows that copper is present.

There are a number of other common alloys which you could prepare if you cared to do so. These, however, illustrate the process sufficiently and only a few others will be enumerated here. *German Silver* consisting of copper, zinc and nickel, is very important as an electric resistance wire. Contrary to the common supposition, it contains no silver. To show the presence of copper add nitric acid and excess of ammonia as above. Gun metal, coin silver, coin gold and nickel and aluminum bronze are among the more common alloys.

Some Iron Alloys

By far the most useful of all the metals is iron. Yet pure iron is a curiosity. Very few people have ever seen the pure, soft, ductile and silver-white metal. So great is its affinity for oxygen that, even if it is prepared in the pure state, it quickly rusts on the surface to iron oxid unless special means are taken to prevent this action. Every year the blast furnaces of the world turn out 72 million tons of iron but in that same time a quarter as much returns to its original form of iron oxid.

It has been found, however, that steel alloyed with 25 per cent. of nickel will not corode and is also non-magnetic. The steel is also made stronger and tougher.

Steel containing 15 per cent. of silicon is rust-proof and will resist the action of strong sulfuric, nitric or acetic acids. Neither will the dilute acids affect this alloy. In America this product is known as "Buflokast."

Chromium alloyed with steel gives a product that is exceedingly hard and of great penetrating power. In connection with nickel, which adds elasticity, it is used in the steel for projectiles, big guns and armor plate.

Tungsten prevents the softening effect of high temperatures on steel and increases its hardness. It is used in making high-speed steel for lathe tools. Tungsten also increases the magnetic retentive power of steel and is used in making permanent steel magnets for use in electrical measuring instruments, where the strength of field must be uniform from year to year.

Vanadium, a very rare earth metal,, has the most powerful effect upon steel for the quantity used of any element known. As little as 0.2 per cent. raises the tensile strength and elastic limit of mild steel by 50 per cent. It trebles and quadruples the cutting qualities of high-speed steels. The heat developed does not draw the temper. It also produces what is called "anti-fatigue" steel. Steel that is alternately under tension and compression tends to become brittle or "fatigued," but vanadium prevents this. It is used in making automobile springs, engines, tractors, etc.

Molybdenum and ***uranium*** are also used in steel and today steel having many desired qualities can be made by alloying with the iron small quantities of the various metals.

Prevention of Rust

Iron is more easily oxidized than other common metals and the matter of rust-prevention is of the utmost importance. Oil can be used in a thin film but for most purposes this is unsatisfactory. For many years plating iron with other metals such as copper, nickel, zinc and tin has been found a very effective means of rust-prevention. Of all these metals zinc is the best, for as explained in the preceding article in this series, zinc is negative with respect to iron, and therefore, when any of the zinc is worn away exposing the iron, the zinc must oxidize in preference to the iron and zinc oxidizes very slowly.

Galvanizing Iron

Iron can be galvanized by dipping it into molten zinc. To carry out this process fill a sand or fire clay crucible with zinc and melt it over a Bunsen burner. Then select a large "cut" nail and strongly heat it in the flame of a blast lamp or, if you have none, the flame of a Tirrill or Bunsen burner. After cooling carefully clean it with hydrochloric acid and sand. Wash off all the acid and dirt and then reheat. While still hot dip it into some olive or cotton-seed oil and then plunge it into the molten zinc. Upon removing and cooling you will find that the portion which has been dipt in the zinc has become galvanized.

Expose this galvanized nail to the weather and note the effects upon it as compared with the action upon an ungalvanized nail.

Tin Plate. Tin plate can be prepared in the same way as galvanized iron, substituting molten tin for zinc.

Other Alloys

By the addition of five to ten per cent. of magnesium to aluminum, an alloy is obtained that is almost as light as aluminum and nearly as strong as steel. This is called *magnalium.* An alloy consisting of 90 per cent. aluminum and 10 per cent. calcium is both lighter and harder than aluminum and is not so easily corroded. An alloy called *palau,* consisting of 20 per cent. palladium and 80 per cent. gold, makes a satisfactory substitute for the platinum of crucibles in the chemical laboratory and costs only half as much as platinum. A similar alloy called *rhotanium* has recently been introduced. An alloy called *invar* and made up of 36 per cent. nickel, 5 per cent. manganese and the rest iron expands and contracts almost none at all with changes of temperature, and is used in watches and measuring instruments.

Electrical Marvels Startle Delegates

(*Continued from page* 975)

simultaneously received over the circuit and deciphered by an automatic apparatus. It was shown that any plain text message could be deciphered easily and accurately at great speed with absolute secrecy, and that the running cipher key used, consisting of a succession of characters, could easily be altered within fifteen minutes.

Research Laboratory Wonders

The delegates witnessed everything from the electrical recording of the energy furnished by the beating of the human heart to the reproduction, on what was described as an oscillograph, of a picture of the human voice and its vibrations. Eminent men among the delegates sat before an instrument which registered through electricity their own bodies generated the beating of their hearts and as each arose from the chair a photographic record of his heartbeats was handed to him. During the projection on a screen in a dark room in the electrical recording of the vibrations of the human voice, one of the scientists of the laboratory talked into a telephonic receiver an address in which he described the wave lines of his own voice as his lecture was projected in a vibrating line on the screen.

The visitors were almost bewildered by the rapid succession of things of this sort shown to them and were especially interested in the apparatus which will be used when the entire telephone system of New York City is transformed from a manual system to a new developed form of automatic telephony.

Building a Small Automobile

By H. WINFIELD SECOR

(*Continued from page* 992)

It is understood, of course, in either case, whether utilizing two or four electric motors, that the wheels rotate freely on the shaft and are not secured thereto in any manner. A speed control and reverse action can be readily constructed with a switch, some resistance wire, or simply using iron wire for the rheostat coils.

To reverse any motor, whether of the series or shunt-wound type, the field or the armature connections, but not both must be reversed, necessitating the carrying of four wires from each motor to the reversing switch and controller. Such a machine has been built, using a regular automobile starting motor, rated at about one-half horse-power, this motor operating on six volts, and requiring of course, a considerable amperage. Several ignition batteries can be connected in parallel to supply the necessary current, keeping in mind that the standard, as well as safe discharge rate for lead plate cells, is eight hours; 120 ampere-hour batteries should be discharged at no more than the rate of 15 amperes for eight hours, normal rate, etc.

With a one-half horse-power auto starter motor, you will require about from 400 to 500 amperes at full load; a sufficient number of batteries should be connected on parallel to permit of the normal eight-hour discharge rate.

At Fig. *D,* is shown the usual arrangement with gasoline engine or single electric motor power plant, centralized and caused to drive the two rear wheels of the vehicle

(*Continued on page* 1026)

Popular Astronomy

By ISABEL M. LEWIS, M. A.

(*Continued from page 987*)

moon to full moon it will therefore, rise *after* the sun and set *after* the sun. The waxing crescent moon will not be visible in the morning hours because it rises *after* the sun, and is lost to view in the brilliant solar rays. Nevertheless, it follows the sun

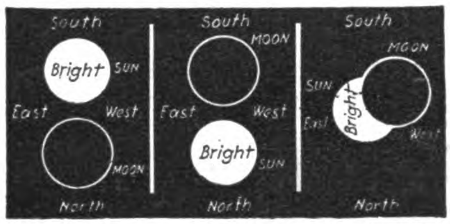


Fig. 1. The New Moon. Showing the Three Different Relative Positions that the Sun and Moon May Occupy at Time of New Moon.

across the sky and becomes visible in the west as soon as the sun's rays have disappeared below the western horizon. The thin illuminated crescent has its horns or cusps turned *away* from the point where the sun has set. The horns of the crescent can never point *towards* the horizon since the illuminated side of the moon is always turned towards the sun whether the sun is above or below our horizon. For the exact form and appearance of the waxing crescent moon see Fig. 2.

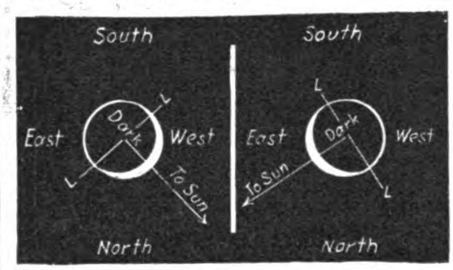


Fig. 2. The Crescent Moon.

Left—The Waxing Crescent Moon. The Width and Area of the Crescent Increases Continuously from New Moon to First Quarter. The Distance of the Moon East of the Sun Increases Gradually from 0° to 90°, and the Moon Appears Higher Above the Western Horizon at Sunset Each Successive Evening.

Right—The Waning Crescent Moon. The Moon Is Now Visible in the East Before Sunrise. Its Altitude Above the Eastern Horizon at Sunrise Is Less Each Successive Evening from Last Quarter to New Moon and the Crescent Is Decreasing Gradually in Size.

The Crescent Moon Is Always Convex Toward the Sun So that the Horns, or Cusps, Are Always Turned Away from the Horizon. The Line Connecting the Cusps LL' Always Passes Thru the Center of the Disk and a Line Drawn Thru the Center Perpendicular to LL' Points to the Sun. The Faint Illumination of the Dark Portion So Frequently Seen at the Crescent Phase Is Due to the Fact that the Earth as Seen from the Moon Is Now Nearly "Full" and We See this "Earth-Shine" Reflected Back to Us from the Lunar Surface.

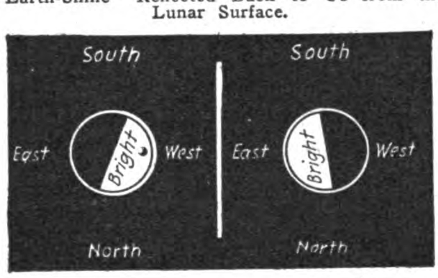


Fig. 3. The Moon at First and Last Quarter. Left—At First Quarter, About Seven or Eight Days After New Moon, the Western Half Fully Illuminated. The Moon Is Now 90° East of the Sun and on or Near the Meridian at Sunset. Right—At Third or Last Quarter, the Eastern Half Fully Illuminated. The Moon Is Now 90° West of the Sun and On or Near the Meridian at Sunrise.

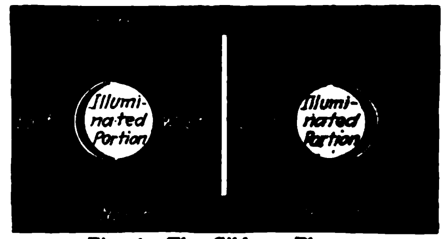


Fig. 4. The Gibbous Phases.
The Shape of the Illuminated Portion Is Now That of a Circle Minus a Crescent. This Is the Phase Seen Between First Quarter and Full Moon and Between Full Moon and Third Quarter. Left—The Distance of the Moon East of the Sun Increases from 90° at First Quarter to 180° at Full Moon. The Western Limb of the Moon Is Fully Illuminated, the Eastern Limb Dark or "Defective." Right—The Moon Is Between 180° and 90° West of the Sun. The Eastern Limb Is Now Fully Illuminated, the Western Defective.

As hour by hour and day by day the waxing crescent draws farther and farther eastward and increases its angular distance from the sun we see more and more of the illuminated side; the crescent increases in width and area and the moon appears higher in the western sky each night at sunset.

Usually about seven and a fraction days after the date of new moon the moon completes the first quarter of its revolution around the earth. The period from one phase to the next is variable and irregular

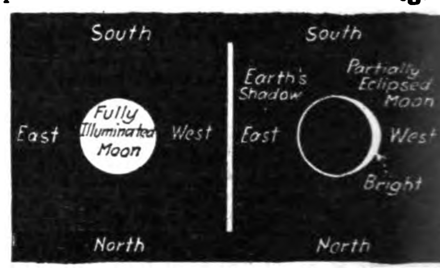


Fig. 5. The Full Moon.
Left—The Moon Is Now 180° East, or West, of the Sun. It Rises in the East About Sunset, Is Nearly Due South at Midnight and Sets About Sunrise, and Is East of the Meridian the First Half of the Night and West of the Meridian the Second Half of the Night. Right—The Earth Is Now Directly Between the Sun and Moon and at This Time Lunar Eclipses Occur When the Moon Is Near Its Nodes or the Points Where Its Orbit Crosses the Ecliptic.

being sometimes less than seven days and at other times more than eight days since the rate of revolution of the moon is not uniform.

When the moon has completed the first quarter of a revolution it is ninety degrees east of the sun and presents the phase

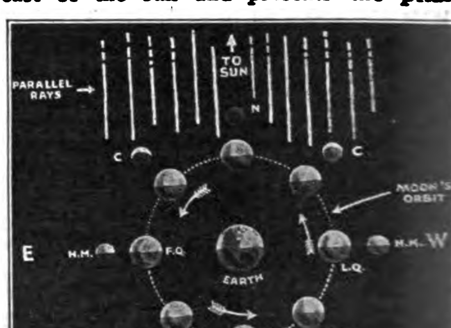


Diagram I. To Show the Various Phases of the Moon at Different Points in Its Orbit. The Rays of the Sun Fall upon the Moon from a Point Above the Plane of the Paper and the Motion of the Moon Around the Earth Is from West to East in the Direction of the Arrows. The Outer Circles Represent the Appearance of the Moon Viewed from the Earth When at the Points in Its Orbit Occupied by Inner Circles at Corresponding Positions. The Dark Portions Are Unilluminated by the Sun. N—New Moon. C—Crescent Moon. F.Q.—First Quarter. H.M.—Half Moon. G.—Gibbous Moon. L.Q.—Last Quarter. F.—Full Moon.

known as "half-moon" since half of the surface that is turned toward the earth is illuminated and half is in darkness. It is at the first quarter. The illuminated half is of course the western half because the sun is to the west of the moon. The half moon is near the meridian at sunset in mid-latitudes and sets near midnight. Up to the first quarter, then, the moon is a crescent in the western sky during the first part of the night and should never be represented as *east* of the meridian or near the meridian at midnight.

After the moon has passed the first quarter and before it is full more than half of the side turned toward the earth is illuminated and it is in the "gibbous" phase. It is still the western limb that is fully illuminated. The moon is now east of the meridian at sunset and it crosses the meridian before midnight and sets before sunrise. All engaged in outdoor pursuits during the first half of the night find this phase of the moon more favorable to them than the gibbous phase *following* full moon.

The moon now being above the horizon at sunset is visible continuously from sunset to midnight but sets some time during the second half of the night, while the full moon shines thruout the night rising in the east about sunset and setting in the west about sunrise.

When the moon is full it is 180° east, or west, of the sun and so both its eastern and western limbs are perfectly illuminated. After the full the moon goes thru its phases in reverse order being first gibbous then a half moon once more and lastly a waning crescent.

It is now *west* instead of *east* of the sun and so it is the *eastern* limb that is fully illuminated by the sun. Being west of the sun it will now *rise before the sun* and *set before the sun* the interval decreasing each day as the moon draws in toward the sun and the phase of new moon once more.

The gibbous phase preceding full moon is favorable to all abroad before midnight but the gibbous phase following full moon is more favorable to those who are abroad after midnight for from full moon to last quarter the moon is below the horizon at sunset and of course is rising later and later each night while at sunrise it is still above the horizon appearing higher and higher above the western horizon at sunrise as it approaches the third or last quarter.

When it has reached this point it is once more a half-moon tho now it is the eastern half instead of the western half of the disk that is fully illuminated. The moon is 90° west of the sun at third quarter and from this phase to the phase of new moon it is a crescent once more tho now a waning instead of a waxing crescent. It appears east of the meridian before sunrise and as the crescent grows thinner it draws nearer and nearer to the eastern horizon and the rising sun. As with the waxing crescent moon the horns are turned away from the horizon. The waning crescent moon is always to be looked for *east* of the meridian and to be associated with the rising sun while the waxing crescent moon is to be looked for west of the meridian and associated with the setting sun. Neither the waxing nor the waning crescent moon is to be found near the meridian around the midnight hours.

As the waning crescent moon grows thinner and draws in closer to the sun each successive night its time of rising precedes that of the sun by an ever decreasing interval until finally the crescent disappears from view in the eastern sky; the next day we see no crescent either in the eastern or western skies the moon is once more in conjunction with the sun and "new." One revolution of the moon about the earth has been completed and a day or so later we may look for a new crescent moon in the western sky after sunset.

A Fairyland of Bubbles

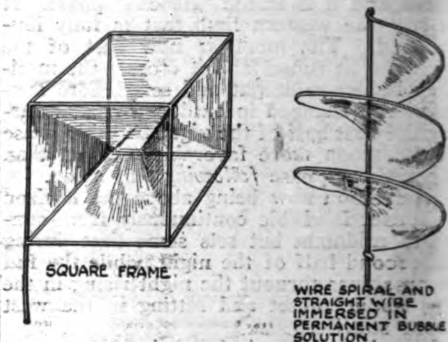
By JOSEPH H. KRAUS

(*Continued from page 964*)

namely, that of blowing permanent soap bubbles.

Blowing Permanent Soap Bubbles

The liquid for the next experiment will have to be made up in more or less of a



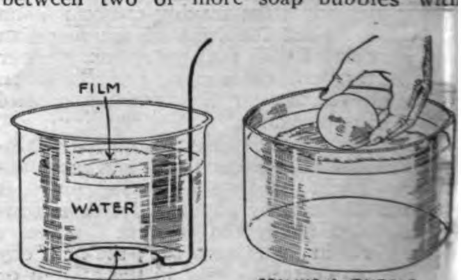
Two Wire Frames, as They Appear When Removed from the Permanent Bubble Solution. These Frames May Be Inserted into a Stand Preferably Made from a Cork Stopper and Can Then Be Put into a Curio Cabinet or a Laboratory Show-Case and Preserved for Future Use.

haphazard manner as different soaps and different constituents cause different effects. The ingredients are readily obtained from any pharmacist. About six ounces of acetone is placed in a bottle to which is added enough celluloid film to make the solution quite thick. To a similar quantity of acetone, about one ounce of powdered Ivory Soap is added. This soap has been found to be very satisfactory. The solutions are allowed to stand for 36 to 48 hours.

These solutions are then mixed together until of such a consistency that they can be blown with an ordinary clay pipe in the same manner as soap bubbles, a bubble about four inches in diameter being the maximum size produced.

The ends of the pipes are then stopt up with a wooden plug or with wax and the stems inserted into racks. It will be found that after allowing them to remain this way for twenty-four to thirty-six hours, a quick snap of the pipe will separate the bubble and the same can be caught upon a stretched cotton sheet.

Thereupon, the bubbles can be built into all sorts of fantastic forms. Houses can be erected, bridges built, and castles permanently made as shown in the illustration of the "bubble castle" herewith. In order to do this with a marked degree of success so that if the castle or the object built is to be moved, and not to break, it will be necessary to moisten the point of contact between two or more soap bubbles with



Above Is Shown a Film, Made as in the First Experiment, Floating on the Surface of Water in a Transparent Container. Note How the Wire Circle Is Bent to Facilitate the Removal of the Film Intact. One Single Drop of the Solution Forms a Film Whose Diameter Is About 6 Inches. A Similar Method Is Used in Sealing the Bubbles.

a very little of either of the solutions just mentioned; either with the amyl acetate and celluloid solution or with the acetone-celluloid solution.

Coloring the Bubbles

In this manner, the bubbles will last intact for upwards of three years. Another very pleasing and interesting combination is to color some of these with soluble analine dyes. These dyes if delicately handled will give a very faint predominating color characteristic of the bubble, and if an ordinary electric lamp is placed back of a castle built in this manner, very wonderful effects will be produced.

It will well repay any experimenter to delve into such an interesting phase of bubble-blowing.

These bubbles can be blown and then filled with hydrogen, when they will make ascents to great heights. A film produced as in experiment one, can be used to cover the aperture left by the pipe. In order to close this hole, it will be only necessary to float a film on the surface of some water and rest the bubble on the film lightly, a short time after it is produced.

Upon removing the bubble the aperture will be found to be completely closed.

Wire frames of various shapes, the one condition of their construction being that they must be closed into loops or other

A Triangular Frame Immersed in the Solution of Experiment (Two) Shows How Peculiarly the Film Shapes Itself So That the Three Films Meet Each at an Equal Angle. Any Sort of a Closed Loop Which May Be Devised by the Experimenter Can Be Dipped into the Solution and Removed Whereupon if Allowed to Dry It Will Give a Permanent Article of Considerable Beauty. These Frames after Standing for About One Week Develop Remarkable Colorations. They May at the Same Time Be Colored by an Analine Dye after Which They Assume a Predominant Color Characteristic.

form, if immersed in a bubble solution, give very beautiful effects, developing all sorts of surfaces. The shape of the surfaces is based on the general law that the film will endeavor to take the shape of smallest area. In the illustrations, several such loops are shown filled with film and the experimenter will have plenty of chances to exercise his ingenuity in producing different shapes of frames. The frames may be made about an inch long on the straight sides. Of course, some may not be bounded by straight sides, but the above gives a general idea of about how large they may be. They may be preserved when filled with film for an indefinite period.

CORRECTION NOTICE

On page 752 of the November issue, a mistake was made in the cut of the "Automatic Temperature Indicator." The wire from the upper end of the battery should connect to the top of the set of resistance coils, instead of to the bottom.

Building a Small Automobile

(*Continued from page* 1020)

thru a *differential* or equalizing gear. Those desiring to build a machine of this type can probably secure a differential gear and rear axle from the builders of low-priced automobiles, or possibly from second-hand dealers, or a local garage who may have an old one at hand, discarded from a worn-out machine.

The next interesting subject in the development of a *differential-less* automobile is that shown at Fig. *E*. This is what we might term a "lop-sided" or unsymmetrical tricycle design. It involves the exact principle used by thousands of motorcyclists today, when they attach a side-car to their machine. Here, the motive power, whether derived from an electric motor or gasoline engine, is applied to one rear wheel, the steering being taken care of by the forward wheel. This principle is not efficient or at all desirable in a large vehicle, even in a lightweight automobile of the usual type, such as a Ford. For small motor vehicles or motorcycles of this weight, however, it serves its purpose admirably, as any motorcyclist can affirm.

Going this idea one better, we give the sixth arrangement suggested at Fig. *F*, which has been used now and then by builders of small automobiles and which overcomes the difficulty of procuring a differential gear. Here the four wheels are run loosely on the axles and the power is applied by chain, belt or gearing to only one of the rear wheels in the manner shown. This method of driving a four-wheeled vehicle causes considerable abnormal wear and tear on the single driving wheel to which the engine power is applied, but as some wag has remarked, "We can't have everything!"

Building a Small Motor Tricycle For One or Two Passengers

Having discust the important principles as to how we are going to drive such a small motor vehicle as we are now considering, we might as well follow the trend of European development and select the efficient forms of small motor cars, requiring no differential or other complex machinery for their operation.

A suggestion for a home-made wood or metal body is given in the illustration at Fig. 2-*A*. The dimensions are not given as the builder will invariably make this somewhat to suit himself, keeping in mind, of course, the vital point that the weight must be kept down to the lowest possible limit.

The iron frame forming the chassis for this three-wheel auto may be formed of a substantial size of angle iron, channel iron or plain flat iron bar, but either of the first two mentioned are much more preferable owing to their rigidity and resistance to bending stresses. The vehicle should be fitted with two medium size auto headlights either of the gas or electric types, as well as a tail light. The two license number plates are placed on the front and rear of the machine in the usual manner.

Fig. 2-*B* shows several suggestions for building the suspension springs between the axle and forward wheel and the frame. The Smith motor-wheel is particularly well adapted to the design which the writer has here worked out, and illustrated at Figs. 2-*A*, 2-*B* and 2-*C*. The steering is controlled by swinging the long handle from right to left, the same as featured in some of the British and other European machines of this identical type, and which have been built by the thousands, and should there-

(*Continued on page* 1029)

PATENT ADVICE

Edited by H. Gernsback

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

How to Advertise an Invention*

By JAY G. HOBSON

THE preferred way of advertising an invention depends entirely upon what disposition the inventor wishes to make of his proposition.

If it is desired to sell outright, on royalty or to form a company to manufacture and market it, the copy of the advertisement must be written accordingly to appeal to the class wanted. The advertisement written to interest the cash buyer probably would fail to attract the investor or manufacturer on a royalty basis. The copy must be written with its particular appeal to obtain the desired results.

The reason most inventors fail to profit by their ideas can be plainly seen after a little consideration of examples proving the point.

Few, and they are the successful ones, know how to place their inventions before the proper parties to effect a profitable sale. The analysis of the inventor himself easily explains this peculiar fact. Ninety per cent are either mechanics or average persons with a mechanical turn of mind having no business nor selling ability, which is invaluable in disposing of improvements.

Lacking in knowledge of how to sell, the inventor is easily imposed upon by those who know the selling art. Therefore, it becomes the purpose of this article to impart a portion of this knowledge so that people with practical ideas may succeed in getting their just deserts.

For example, we will take the inventor wanting a cash price for his improvement. He seldom knows the right amount to ask because his inexperienced vision is unable to see the correct commercial possibilities and realities what they are.

Instead he thinks in millions when more than likely five thousand dollars would be a good price. The reason for this mistaken valuation is his unfamiliarity with commercial propositions.

Naturally he often asks a figure far beyond the ability of most buyers, altho there have been a few cases that I remember where the inventor undervalued his patent when he probably could have obtained more. But this is the exception.

It is true, the buyer tries to pay just as little as possible, but he usually knows the limit on the upward bid. But there is no limit going down, for the nearer he can buy a thing for nothing the more he has saved and the happier he is.

The secret for the inventor is to know when the buyer has reached his upward limit and clinch the deal right there without further risk of having to sell for less. This can be done with careful study of business dealings, also of human nature. The close observer will soon notice that the average buyer has his mind pretty well made up on the purchase price he can afford to pay when he investigates it.

The scheme is to draw the top offer from the buyer before quoting him the final price. This is possible by asking for bids and holding off quotations until absolutely necessary to close the deal. Something in this manner should prove effective:

The Buyer: "Well, what is the least you will take for your patent rights?"

Inventor: "What is the most you will pay. I know the large commercial possibilities of my improvement but do not know your circumstances. You tell me how much you will give and I will tell you frankly if the figure is acceptable. As the inventor I feel it my prerogative to have your offer first."

This presentation of your position in the matter should bring him out, so you may be able to learn the amount he has in mind, if not, then as a last resort make your quotation within reasonable limits for both parties.

Of course, the greatest difficulty inventors find is in getting their improvements before the logical buyers to whom they will appeal for purchase. Experience has repeatedly proven advertising to be most effective as the medium of introduction. But a poorly written advertisement holds the same relation to inefficient selling as does the inventor without knowledge of salesmanship. Both must have the punch of pre-

*No queries are publisht this month owing to the article by Mr. Hobson.

sentation, interest, information and conviction to succeed in the mission.

The inventor who knows little of selling, knows as little of writing advertising copy, and herein lies the germ of failure many people become inoculated with after receiving their patents and trying in vain to find some one to whom they can sell them profitably. It appears to me the main reason for this discouragement and failure rests in their inability to obtain a means of connection between themselves and the buyer. With a view to suggesting three feasible avenues I submit the following advertisements for use under classified space in newspapers, magazines and the like. These little adlets often prove more effective than larger display type and cost very much less.

The first one is written to appeal to the cash buyer:

"FINANCIAL OPPORTUNITY"

$10,000 Cash will buy outright recently **patented** hardware improvement with **large de**mand waiting national distribu**tion to** make a great commercial success. **Parties** able to market this exceptional **propositi**on should investigate immediately. **Address,** etc.

This one is for the royalty buyer:

"MANUFACTURER'S ATTENTION"

A reasonable royalty contract will secure **exclusive** rights to my new improvement **on practi**cal hardware necessity just pat**ented.** The large commercial possibilities **of this ex**ceptional invention will be seen **immediat**ely upon investigation. For in**formatio**n, address, etc.

And for the investor:

"INVESTORS WANTED"

To cooperate profitably with inventor **holding** valuable Government patent rights **on novel** hardware necessity with uni**versal de**mand waiting introduction. An **appeal is** made to a limited number for **the purp**ose of raising sufficient capital **to marke**t this meritorious product. This **is an** unusual opportunity for making **large pr**ofits from a small investment. **Your pr**ompt investigation will convince **you of th**e integrity of this excellent bus**iness pro**position. Send at once for par**ticulars.** Address, etc.

When letter or personal replies are received in answer to the above it is necessary to answer them promptly, either in person or by letter, making an appointment for a complete demonstration of the invention. After the demonstration is the psychological time to close the deal.

(*Copyright* 1920)

HOW ODOR TRAVELS.

The rapid propagation of smells noticed in the open air appears due entirely to currents, since in small tubes, where currents do not exist, the rate is found to be very small. Experiments along this line were first undertaken in England by Professor Ayrton, and additional data have been reported in this country.

With ammonia diffusing through a tube a meter and a half long, over two hours elapsed before the smell could be detected at the other end of the tube. Using different lengths of tubing, it was found that the time required for the diffusion of the smell was roughly proportioned to the square of the length. Ammonia and hydrogen sulfid were used for these experiments. The presence of ammonia could be detected chemically at a point in a tube after about the same time as when the sense of smell was used for a detector. The rate of propagation of the smell of ammonia was not markedly different when this had to pass along the same tube either horizontally or vertically upward or downward. With camphor, however, while the rates horizontally and downward were about the same, the speed upward was about twice as great. The smell given to iron and brass by rubbing these with the fingers was also tried, but gave no definite results.

Building a Small Automobile

(*Continued from page* 1026)

fore offer no objection to the embryo motorist; he should not object because this design doesn't seem to resemble the usual steering wheel control found on practically all American autos. But for those who prefer to have the usual and ordinary wheel control and gear scheme, this feature is shown worked out in Fig. 3, in conjunction with a special type of tricycle having an engine placed under a bonnet, mounted just ahead of the dash.

One form of wiring, suitable for this tricycle is shown at Fig. 2-*C*. This is adapted for use with a storage battery which may be charged from time to time.

A Special Independent Type of Tricycle

Oftentimes one may have available or might be in a position to procure reasonably a small one or two-horse-power engine such as those sold for doing farm chores and general utility purposes, which they might like to employ for driving a small auto of this type.

The writer has worked out some features, which in detail will be subject to some additions, particularly as to bracing and solidity of the various parts which are illustrated in Fig. 3, suitable for the employment of an independent engine. We remember seeing one commercial motor tricycle which had an engine mounted on top of the vertical shaft over the front wheel, high in the air, and directly in front of the passenger's line of vision. The writer does not think very well of this arrangement for several reasons, and does not believe that the reader would like to place a heavy engine in such a conspicuous and awkward position. Figure 3 shows a scheme whereby the power is applied from the engine to the front wheel thru a system of gearing, at the same time permitting the turning of the front wheel on its vertical axis so as to readily steer the auto. The front wheel may be of steel or of the usual wire construction, and Fig. 3-*A* shows a front sectional view of the wheel mounted on its journal or shaft, arranged to be rigidly secured at right angles to the vertical steering shaft.

A beveled gear (1) is secured to the front wheel and is driven by a beveled pinion (2) secured to the hollow steel shaft (3), which revolves freely about the vertical shaft proper (4). To the upper end of the hollow shaft (3) is secured a second beveled pinion (5), driven by a third pinion (6). Beveled pinion (6) is secured to a horizontal driving shaft (7). This shaft is driven by the clutch (8) which can be slid into contact or away from the revolving worm gear (9). The clutch is formed in the manner shown, the iron disc (8) with its Raybestos or Thermoid (or leather) covering being forced into contact with the flat face of the disc secured to worm gear (9), thru the lever and foot pedal arrangement shown in full detail in drawing, Fig. 3-*D*.

Normally the foot has to be pushed on the pedal to keep the clutch disengaged as as in most modern motor cars, and when the foot is released, the clutch is cut "in." The free running worm gear (9) is driven by the worm (10) secured to the vertical driving shaft (11). Shaft (11) is revolved by either one of two pinions (12 or 13), and here is where the drive is reversed, so far as the front wheel is concerned. Either pinion (12 or 13) may be put in mesh with the beveled gear (14) mounted on the fly wheel (15) of the engine.

The Elixir of Life

By H. L. JOHNSTONE

(*Continued from page* 982)

tion against a man older than yourself, and a man of science at that?"

"I mean, er, that it doesn't seem possible," stammered the rattled Billie.

"Yes, I'll admit that it doesn't seem possible," replied the professor, "but remember, young man, that I have been a student for years, and you a clerical laborer. You add up figures, while I use my brains to search out the mysteries of life. I will prove my statement to your satisfaction. I will show you with this cat."

The professor picked up a glass medicine dropper and carefully measured out two drops of the green liquid.

"Get me a dish of milk," he said to Marie. The milk was brought and the professor placed the two drops in it. He woke up the cat, who stretched himself and glared about him. The milk was placed before him, and he started to drink it greedily, his slick tongue causing the only sound heard in the laboratory as the three watched him expectantly.

For two or three minutes after the last trace of milk had been devoured, nothing happened and Billie looked slyly at Marie and winked. Marie smiled and then clutched his arm.

"Oh, Billie, look! Look at that cat!"

"Hush," cautioned the professor, holding up a shaking forefinger to his lips. Before their eyes a strange thing was happening. The old wretch of a cat was slowly but surely shaking off the fetters of old age and becoming a kitten. The torn ear faded away and in its place grew a new one. The tail grew out slick and shiny.

In her excitement, forgetting the warning to keep quiet, Marie exclaimed:

"Oh, the cute little darling. Let me hold it, father." The professor turned to Billie and smiled.

"Now, what have you to say about the Elixir of Life?"

"It's wonderful. Will it work on human beings?"

"I haven't tried it yet, but it will; I'm sure of that."

"What good will it do?"

"I was going to tell you, Billie. It will be one of the greatest blessings that science has ever given to the world. Suppose you had reached the age where you were no longer of any use to yourself or the world either, and looking backward with the wise old eyes of wisdom, gained through all your years of life and experience, you saw the hundreds of errors you had made, the sorrow and suffering you had caused, because you didn't know any better. What would the elixir be worth to you then Billie, if you knew that it would turn back the years, make a young man of you once more, give you a fresh start in life; a life of success; for you would be bound to succeed with such a brain as yours to direct it. With the elixir, men can live for hundreds of years, and grow wiser and wiser, delving into the secrets of life until they will eventually rival the gods of intelligence and understanding."

The rejuvenated cat had been walking around the table while the professor was talking. The little thing was meowing.

"What's the matter with the kitten?" asked Marie.

"Sounds as if he is hungry and asking for something to eat," replied the professor, smiling.

"But that is impossible, father. He just had a dish of milk a few minutes ago."

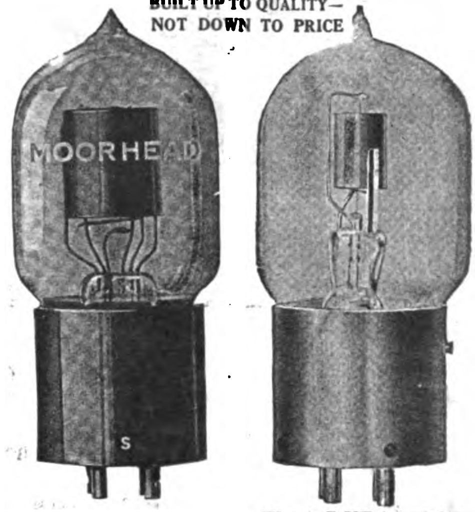
"Yes, so he did, Marie, but, according to the way I look at it, he had it ten years ago."

(*Continued on page* 1032)

—and never forget

You radio amateurs who really take a pride in getting results, never forget one thing—a vacuum tube can be either a detector or an amplifier, but not both efficiently. Never buy a vacuum tube advertised as both a detector and an amplifier—no, not at any price. No one tube can serve both purposes efficiently. That is an established fact. You know it. Only a combination of tubes provide all necessary operating characteristics without compromising essential features. And the A-P Vacuum Tube Combination is the one such proven combination on the market to-day.

BUILT UP TO QUALITY—NOT DOWN TO PRICE



The A-P Electron Relay, equipped with the SHAW standard four-prong base. Price $6 and worth it. Order from your dealer.

The A-P VT Amplifier-Oscillator, equipped with the SHAW standard four-prong base. Price $7 and worth it. At dealers.

A combination of two or more A-P VT tubes as amplifiers with an A-P Electron Relay as the initial detector or oscillator is the ideal receiving combination for long distance amateur or long wave reception. Only with such a combination can full efficiency be attained.

When you want an efficient amplifier in which none of the amplifier qualities are sacrificed to make it also a detector, use the A-P VT Amplifier Oscillator. When you want an efficient detector in which none of the detector qualities are sacrificed to make it also an amplifier, use the A-P Electron Relay.

The A-P Electron Relay is the most sensitive spark detector known to the radio art. It is a soft tube. It contains the right quantity of gas and, equally important, the right kind of gas. The electrodes are correctly designed. You know this tube will give you results. On the market since May, 1920, it has made good in actual use.

For sure results, for better results use A-P Tubes—built up to quality, not down to price. Manufactured under the De Forest Audion and Fleming patents. Other patents applied for and pending.

The Atlantic Radio Supplies Co.
8 Kirk Place, Newark, N. J.

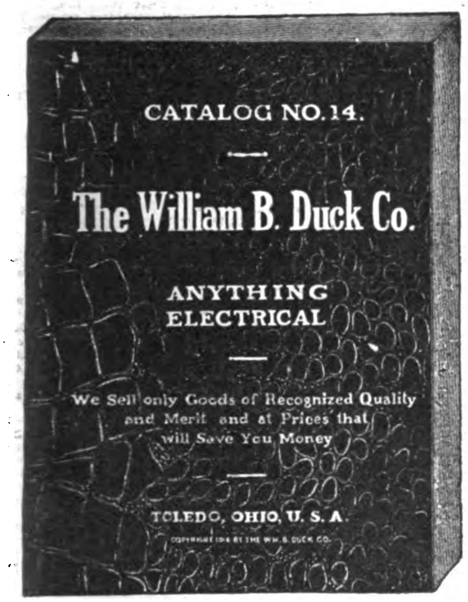
The Pacific Radio Supplies Co.
638 Mission St., San Francisco, Cal.

Distributors for Moorhead Laboratories, Inc., Manufacturers of

The A-P VACUUM TUBE Combination

"The Greatest Radio Catalog in the World—" *The Universal Verdict of Tens of Thousands of Radio Amateurs*

DUCK'S No. 14 Big 200 Page Wireless Catalog



TREMENDOUS CHRISTMAS STOCKS—

WITH a business of unprecedented volume ever since the close of the war. With nothing short of miserable service from our many sources of supply, and many other unusual conditions to contend with, we found it impossible, up to a comparatively short time ago, to give the service on orders for which we always enjoyed such a high reputation, and which was our pride. We deliberately curtailed our advertising, because we could not get catalogs printed fast enough and because we did not want a volume of business we could not expeditiously handle. We are now able to guarantee the wonderful service that our thousands of patrons received for many years before the commencement of the war.

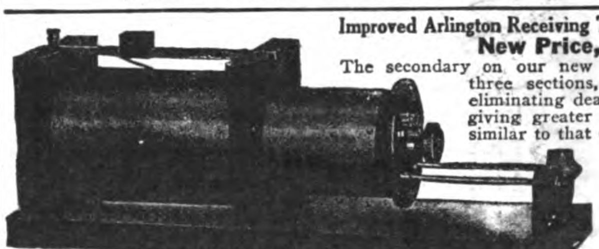
Announcing Permanent Reductions on 3 of our most popular Radio Instruments

The demand last month for our Navy Type, Arlington, and No. 7721 Receiving Transformers at the greatly reduced prices convinced us that with large quantity production, because of the exceedingly attractive prices on these instruments, we can continue to maintain these low prices. We therefore announce the following permanent reductions on these instruments.

Model 5BB Navy Type Receiving Transformer, Former Price $27.50. **New Price $21.95**
No. 1091 Improved Type Arlington Receiving Transformer, Regular Price $15.00. **New Price $11.95**
No. 7721 Receiving Transformer, Regular Price $9.00. **New Price $7.50**

Send your order immediately for your choice of these popular instruments.

Improved Arlington Receiving Transformer, Regular Price $15.00
New Price, Only $11.95



The secondary on our new type Arlington is divided into three sections, with two dead end switches, eliminating dead end effect and harmonics and giving greater selectivity. The end support is similar to that on our Navy, permitting a looser coupling. The base and primary end pieces have a spline to prevent warping or damage in transit. This feature is also on our Navy. It is a beautifully finished instrument.

Improved Type Sayville Rotary Gap

Embodies the latest and best features in Spark Gap Construction

Our New Type Sayville Rotary Gap is, we believe, far in advance of any rotary gap on the market within a range even of twice the price. It is the final development of many different types made in our experimental Radio Laboratory. It fulfills every requirement of the ideal rotary gap. It is neat and attractive in appearance; simple and durable in construction; possesses a wonderful motor; has a cast aluminum rotary wheel, beautifully polished; every part is in perfect alignment; there is no wobbling of the rotor; produces and maintains a clear and pure 500-cycle note; is instantaneous in action; permits of no dragging of the spark; has contacts of tempered flat copper of proper length and width, easily and quickly removable, and inexpensively renewable; the stationary contacts are adjustable to any length.—**$27.50**

THE WILLIAM B. DUCK COMPANY, 230-232 Superior Street, TOLEDO, OHIO.

The Elixir of Life

(*Continued from page* 1030)

"So he did," exclaimed Marie pityingly, giving it another bowl of milk. "Poor little thing is sure hungry."

Accordingly, true to the law of the elixir, he must have been hungry, from the way he cleaned up the milk. As Billie watched him lap up the warm fluid, he thought the present a good time to unburden himself, so nerving himself, he opened up.

"Professor, you have made a wonderful discovery. I congratulate you. The world will soon congratulate you, now that you have been rewarded for so many years' hard work, at last. I have something important to ask you," this as he glanced at Marie. She blushed and nodded in the affirmative. "Marie and I have loved each other since we were little ones together. She is now eighteen, and I am twenty-one. I came here to-night to ask you for her hand. What is your answer?"

The professor gave a sudden start. He had been absentmindedly watching the cat. Marie took the test tube from his hand and placed it carefully on the rack, out of the kitten's reach.

"Eh? What's that? Marry my daughter?"

The professor looked from one to the other in amazement.

"Billie, you're a good boy, and I like you. I never thought of such a thing as Marie getting married. Is she really that old? Yes, I guess you are right. I've been so busy that I have lost track of time. So you want to marry her. Well, well, how much money have you got Billie?"

"I have some money in the bank, not very much, but I am making $25 a week, and have good prospects for a raise soon," explained Billie hopefully.

"What is $25 a week? It is not enough to buy candy for Marie."

"Oh, father. Billie and I can do wonders with $25 a week," exclaimed Marie.

"Sure we can," chimed in Billie.

The professor looked them over for a few moments.

"Tell you what I will do. You go ahead and get that raise you were just talking about. When you get it come to me and I will give you my answer. I think it will be 'yes.'"

And so the matter was settled, for the time being at least. The three left the laboratory for the living quarters, upstairs where Billie listened patiently for hours to the professor's discussion of the wonders of his Elixir of Life. At last the professor yawned and Billie took his departure. As he pressed Marie's hand at the gate, he whispered in her ear:

"I'll get the raise dear, so don't worry your pretty head. Good night."

"Good-night, Billie. I am sure you will."

"With such a prize ahead any one would," replied Billie as the front gate clicked behind him.

He went home that night on thin air. As soon as he reached his little room he threw himself on the bed and dreamed of the happiness in store for him. He had $200 in the bank, and prospects for a raise and then—the best little girl in the whole world. What more could he ask for? In this frame of mind, he dropt asleep. Poor Billie. If he had only known what was in store for him, what terrific odds he would have to fight against, he would have broken into the professor's laboratory and destroyed the baleful green Elixir of Life that very night.

Chapter Two

A month past, during which Billie worked as he had never worked before. He was

(*Continued on page* 1034)

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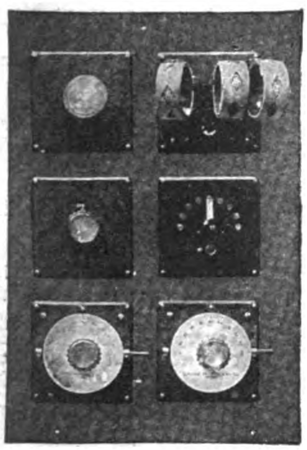

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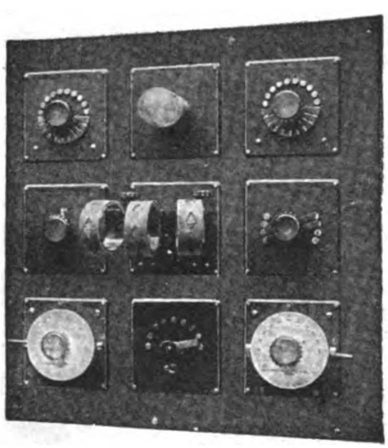
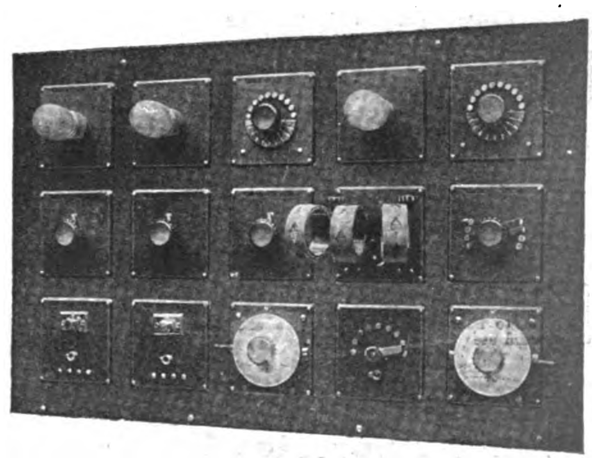


Nine Panel Unit Set

Comprising the same six panels shown above, and either three additional panels to give one step of amplification, or three panels to increase the efficiency of the original six. The former will add about $23.70 to the cost of the original six; the latter about $12.10.



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The Elixir of Life

(Continued from page 1032)

trying to attract a little attention from the "Boss," and at last his efforts were rewarded, for he got his raise. Hooray! Now he could go to Professor Straus and demand Marie's hand. During the last month he had swelled his bank account to $250, and now with the raise he felt quite independent.

Once more he watched the clock, and as soon as the hands pointed to the hour of his release he startled the entire office force with the violence of slamming ledgers and the way he hurried into his street clothes and left the office.

"Billie got a raise today, and it has gone to his head. He's going to paint the town red," remarked old Grubb sagely.

At 7 o'clock Billie prest the bell of Marie's house. When he told Marie about his good luck he was rewarded for his efforts by the glad look that came into her eyes.

"Father is in his study with a Mr. Marco Russell. He is some rich old millionaire, and he is trying to make father sell him the elixir. Let's go in and see them," she said to him.

She led the way to the study where Billie was introduced to Mr. Russell, who, judged by outward appearances, was nearing the century mark. His face was seamed and sallow, shining like some dry parchment. His eyes were faded and sunk deep in their sockets. His body was thin and bent a quarter of the way to the ground by feebleness.

He held out a clawlike hand to Billie, peering at him with dim, near-sighted eyes.

"Glad to know you, Billie," he croaked. "Yes, indeed, glad to know you. See if you can help me out. I want to make the professor sell me some of his elixir, and he is afraid to make the test."

"Why is he, Mr. Russell?"

"He is afraid to make the test on a human being."

"Yes, Billie," broke in the professor, "I am afraid. I have tried it time and time again on dumb animals, but now that a real chance comes, I haven't the nerve to do it."

"What is there to lose?" asked Russell.

"I might kill you."

"What if you did? Look at me. I am an old broken man with only a year left at the utmost. Suppose your test does fail? What have I to lose, while, if it did prove successful, I have everything to gain. See this photo. It is of me, taken when I was twenty-one years old. I'll give you $100,000 to make me look like that once more. Oh, how I long to feel the hot, red-blooded stream of youth go coursing through my veins once more. I'll give you a $150,000 if you will make the test."

The long speech was too much for the feeble man. He wavered and sank into a chair. The photo dropt from his talon-like fingers.

Marie picked it up in astonishment.

"Oh, look! What a handsome man. It seems impossible."

Mr. Russell smiled weakly. "I know what you were going to say, Miss Straus. Never mind I know that I'm ugly now. Isn't old age a wonderful thing to turn beauty into ugliness and nobody sees him do it?"

"Please, father, give Mr. Russell the elixir."

"No, Marie; I cannot do it."

It was then that Billie saw the chance.

"Mr. Russell, will you please excuse us for a second or two? I think I can help you."

"Certainly. Do everything you can to help me. I will reward you."

"I would like to speak to you in private, professor," said Billie.

As soon as they were outside the study Billie took the professor by the arm.

"I got that raise in salary and came to claim Marie tonight. I suppose you would consent, but I have a scheme to offer right now. *I will give Mr. Russell the elixir.*"

"*You?*"

"Yes, *me*. If you will permit me. Here is a chance for both of us to make good. You get $150,000 if you will sell me enough elixir to make Mr. Russell young again. You give me a bill of sale. I will sell it to him and take all the blame. This arrangement lets you out of all responsibility. Is it a bargain?"

The professor pondered long, and then replied:

"It is a bargain, but I will hate myself for the rest of my life, when I think that after all my years of research I was afraid to back my own faith. Come, we will tell Mr. Russell."

Together they re-entered the study.

"Mr. Russell, I have sold the elixir to Billie. He will deal with you."

"Thank goodness for that," exclaimed Mr. Russell, trying to spring up in his excitement. He was too weak, however, and fell back heavily.

"Sir, sit still. You shall have your wish," said Billie, getting down to business. "It will cost you just $200,000. Are you willing to pay the price?"

"Yes! Yes! Bring me pen and ink. I will make you out a check."

The writing materials were brought out and old Mr. Russell made and signed a check with hands hardly able to hold his pen. Handing it to Billie, he begged:

"Now, hurry up and give me the elixir."

Professor Straus entered the study with a glass of water and fifteen drops of the elixir. These he handed to Billie, while Russell watched excitedly.

Billie added the drops to the glass of water and, handing it to Russell, said:

"Drink it. Drink the drink that Ponce de Leon came to discover. Drink away seventy-five years of your life."

Clutching the glass with hands that threatened to spill the precious fluid with their shaking, Russell drained the glass to the very last drop.

Professor Straus, Billie, and Marie crowded closer as Russell dropt back once more into his chair. For two long minutes that seemed as hours to Billie the elixir showed no effect, and then a wonderful change started.

It seemed that old age was falling from Marco Russell with surprising quickness. The bent body straightened, and the face discarded its cadaverous look. The eyes began to shine and fill out their sockets. The long claw-like fingers filled out and before five minutes had past Marco Russell stood before them a handsome man of twenty-five.

"*Oh!* What a handsome man he is now!" exclaimed Marie. Russell looked at her and smiled.

"I might add that you are a remarkable and handsome girl."

Marie blushed and glanced at Billie in confusion. The idea of a man nearly a hundred years old passing pretty compliments. The thought past thru Billie's brain that Marco Russell would bear watching, for he remembered the saying, "There's no fool like the old fool." Yes; he would keep an eye on him.

Chapter Three

Two weeks past by, during which time Billie Hoyt was a very busy young man. The $50,000—his share—received from Marco Russell had completely changed his view on life. He had already severed his connection with the firm of Bronx and Wegan, and was now in search of more aged men with money to trade for youth and the elixir. The most important event tho was his approaching wedding. This function was to be held the coming Saturday. It was now Friday afternoon, and he had much to do.

Russell had been a frequent caller at Marie's house lately, and it bothered Billie not a little, for Russell seemed to be head over heels in love with Marie. Billie trusted Marie absolutely, but the night before, when he had thought Russell too attentive, he asked her about the matter. Her reply had reassured him somewhat, for she had told him that Russell was a joke, and that she could never think of him, except as the very old man she had seen in her father's study. She said that on several occasions he had tried to make love to her, but she had soon put him into his place. Of late he had kept his distance.

Tonight Billie was on his way to her house in answer to a telephonic summons from Marie. She said she was in trouble with her father. He was just about to do something terrible.

At last he arrived, and Marie took him into the study. As usual, Marco Russell was there.

"Billie, what do you think father is going to do?" she asked.

"I haven't the least idea."

"He is going to make himself young with the elixir, and I don't want him to do it. That's the reason I 'phoned for you."

"Why don't you want me young again, Marie?" asked the professor.

"Just because I want you as you are, my dear old father."

"You are selfish, Marie."

"No, I am not, father. Billie, see what you can do with him."

"It will do you no good, Billie, so save your energy. I have here in my hand ten drops of the elixir, and here it goes." Before any one could interfere he had tost down the contents of the glass and stood smiling as the wonderful transformation took place.

"Hooray!" he shouted as he saw his reflection in a mirror. "Hooray! Now we are all young once more. Let's celebrate."

Russell grasped the professor's hand.

"Congratulations, professor. It's great to be young after you have had the experiences of old age. Yes, let's celebrate. Let us also celebrate Billie's and Marie's wedding. I came prepared for just such an event. Billie, will you go out to my car and get the big hamper I left in it?"

"You bet I will!" exclaimed Billie, who had entered into the spirit of the thing, and whose estimation of Russell was now at par. "I'll be right back in a jiffy."

Billie returned in a few minutes, loaded with the heavy hamper. Russell took it from him and placed it on the study table. A view of its contents showed a delicious lunch, and several bottles of wine.

"We will eat, drink, and be merry. We will do it now, for who knows what the morrow may bring. Here, Billie, is a glass of rare old vintage, my own private stock. Drink it down."

Other glasses were filled and the party drank to the coming wedding, and to the elixir.

"Don't you like it, Billie?" asked Marie. Suddenly her face went as white as chalk. "*Oh!* My God! What is the matter with you, Billie? Mr. Russell, what have *you* done to Billie?" With a wild scream she fainted and fell to the floor. No wonder, for standing in clothes that had suddenly grown too small for him, and which gave him a grotesque look as they fell in folds and rolls, was Billie Hoyt, three minutes before the man of twenty-one, now a mere gawky boy of six. As Billie realized what had happened, he shrilled out in boyish rage: "Russell, you are a crook! You gave me the elixir in that glass of wine. I'll——"

"Tut, tut, little man," interrupted Russell sarcastically. "See the pretty kitty? Take it and run along and play with it and don't bother your elders. Perhaps you had better run home to your mamma, for I think she needs you."

Marie opened her eyes. One look and she was again senseless. Russell stooped and lifted her from the floor to kiss her, while the professor looked on in dumbfounded amazement.

Billie rushed at Russell and struck him with puny fists.

"Let her alone, you crook. She is my promised wife," he shrilled.

Russell shoved him aside and placed Marie tenderly in a chair.

"Ha, ha; your promised wife. You make me laugh, little one. What will she do with a kid like you? Bring you up?"

He picked up a glass of wine and prest it to Marie's lips. Billie dashed it aside.

"What are you trying to do? Make a baby of her?"

Russell smiled craftily. "Rather not. Do you think that I am a fool? Marie is going to stay exactly as she is. She suits me best that way."

Marie drank another proffered glass of wine and opened her eyes. She smiled at Billie weakly.

"I know what Russell is trying to do, Billie. By removing you he thinks that he can win me, but he never will. I'll wait until you grow up again."

"Wait fifteen years?" asked Russell. "That's a long time, Marie. You'll change your mind, I'm sure."

"Never," she exclaimed angrily, "and don't you call me, Marie; go away from me. You're a brute and I hate you. Father, what are you going to do about it?"

The professor seemed to come out of a deep study.

"Rather remarkable, Marie. I'll have to look into the matter. Yes, yes." He walked slowly out of the study, mumbling to himself the monosyllabic words, "Yes, yes."

Marie flared up. "You double-dyed crook, what have you done to my father?"

"Not a thing in the world," smiled Russell. "There's just merely something wrong with his upper story. He'll come out of it."

Chapter Four

Billie, his head in a whirl from the terrible shock, hurried home as best he could and threw himself upon the bed to think.

He was certainly in an awful fix now, a mere boy in body, but with a man's brain, which only aided in adding to his mental agony.

He must surely lose Marie now, for it seemed out of the question that she would wait for him to grow up. Horrors, she would be thirty-three if she did that, just fifteen years his senior. No; there was no hope in that direction. He must use his head, and beat Russell at his own game. How would he accomplish it? It surely looked like a hopeless undertaking. True, he had a grown man's brain, but the child's body would handicap him badly. However, the prize was worth working for, and he would do his best. At last he dropt asleep, and when morning came more trouble stared him in the face. He had no clothes in which to make an appearance. What should he do? For a few moments he sat and pondered, and then rang the bell. Soon some one was heard outside his door, then a knock and the familiar voice of Mrs. Barnes, his old landlady.

"Do you wish anything, Mr. Hoyt?" she asked.

"Yes. Will you please come in a moment?" replied Billie, jumping into bed and covering up.

"What is the idea?" he heard her muttering as she entered the room.

"Why, where in the world is Mr. Hoyt?" she asked, looking hard at Billie.

"I am Mr. Hoyt, or rather what is left of Mr. Hoyt." Mrs. Barnes walked angrily to the bed.

(Continued on page 1039)

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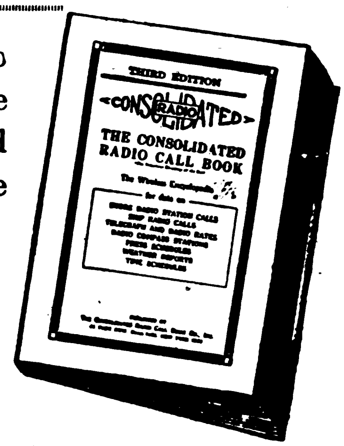

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The Elixir of Life

(*Continued from page* 1037)

"Don't try to kid me, young feller. Don't you suppose I know Mr. Hoyt? He has boarded with me for the last five years."

"I am not trying to kid you, Mrs. Barnes. I am Billie Hoyt. See those clothes scattered all over this room?"

"Yes, those are Billie's clothes."

"Well, he only had one new suit to his name didn't he?"

"Yes."

"Well, there it hangs over that chair. Do you recognize this scar on my forehead? Do you know this ring that is far too big for my finger now? I am Billie Hoyt. I can tell you what I said to you in the hall last night. I was in a hurry too."

"Mercy me! If you are Billie Hoyt, what in the world has happened to you?"

"I was the victim last night of a scientific fraud just like a story in the Arabian Nights. I was set back about fifteen years of my life. What I want you to do is to buy me some boys' clothing and bring it to me here. You'll find the money in that coat. Please keep my secret from the rest of the boarders. Tell them that Billie Hoyt has left on a business trip."

"Mercy me, mercy me!" exclaimed Mrs. Barnes as she got the money and left the room. "Mercy me, the poor boy."

Chapter Five

At Professor Straus' home things were not progressing very smoothly for Marie. The shock of Billie's calamity had unstrung her nerves to such an extent that she had locked herself in and refused to see any one.

Two or three times her father had knocked at the door. Marie was angry with him and feigned sleep. Somehow or other she could not look up at her father, since the change, with the same feeling or respect. He was no longer her dear old gray headed, absent-minded father that she had had to look after as a mother would. She could not think of him as her father for he seemed an entirely new person to her, so she paid no attention to his knockings.

Time and again she thought over poor Billie's plight. Her father was directly responsible for all the suffering his elixir had caused. If he had only let well enough alone and not trifled with the mysterious secrets of life, knowing he had no right to do so, everything would now be all right, and it would be her wedding day with Billie. Poor boy, how she felt for him. She knew that he was suffering as she was. Russell—ugh! How she detested his handsome face. He was a sneak. No wonder he was a millionaire many times over if he had been as ruthless in his business methods as in love.

She would show him. He should never marry her. She would remain an old maid the balance of her life if she couldn't get Billie.

A loud knock sounded on the door and interrupted her brooding.

"Oh, what is it?" she asked peevishly.

"It's your father. Billie is in the study and wants to see you."

"Tell him I'll be right down."

In the study, Billie, drest in a new suit of knickerbockers built for a boy of six, was seated in the big chair and evidently on pins and needles.

As Marie entered the study he jumped and ran to embrace her. Marie stooped to kiss him, and as if the irony of the thing had suddenly dawned upon her, Marie exclaimed:

"Oh, Billie, you poor little boy. It all seems so impossible. Can't something be done?"

"Sit down, dear," Billie said in his shrill, boyish treble. "Sit down and I'll explain our only chance."

For an hour the two conversed in whispers and at last Billie took his leave. He paused at the door and said:

"Remember now, dear, and don't lose hope. I think I have the right solution. In the meantime let them have their own way. The happier Russell gets the harder he will fall."

When Billie left Marie he had tucked under his arm a wicker basket containing the elixired kitten.

For a month Billie kept out of sight. Marie mist him sorely, but it comforted her to know that he was working day and night to solve a knotty problem for their own happiness.

Russell's calls grew closer and closer together until it seemed to Marie that he was living with her father.

One night the professor called Marie into the study, when Russell was there.

"Marie, it is high time you got over your infatuation for a six-year-old boy. You should give a little of your time to Mr. Russell here. He has honored me by asking for your hand in marriage and I have told him 'yes.'"

Marie started back in amazement. "What? I marry Russell? Never."

"Yes you will, Marie. Mr. Russell is very wealthy. He has promised me that he will give me a large sum of money with which to carry on my experiments. Think what that will mean to me now. With the elixir I can ward old age away forever. I can master all the secrets in the universe."

"But, father, I don't love Mr. Russell."

"What if you don't? He will teach you to love him. It's the chance of a lifetime for any girl. Think what it means to your father."

Marie remembered Billie's parting instructions to favor them. She would play a little for time and watch her father. Marie sensed that there was something the matter with her father lately. She looked at Russell. He was staring at her father, as a cat looks at a bird before the spring. She had the answer. Russell had her father completely under his strong willpower. He could make him do as he willed him to do.

"Well, what are you going to do?" asked her father in a strange tone.

"I cannot marry Russell."

The professor looked at Russell appealingly. There flashed something between the two. Turning to Marie, her father said sternly.

"You are trying to disobey me. You will marry Russell this coming Saturday night at 9 o'clock right here in this study. I am tired of listening to you moon around over Billie Hoyt. You act foolishly. The idea. A grown woman making herself sick for the love of a six-year-old boy. Do you understand that you marry Russell at 9 o'clock Saturday night?"

"Y—es."

"Then you are a good girl and you are making me happy."

Russell came towards her and held out his arms.

"Go away from me, you brute. Don't you dare to touch me. I will obey my father, but——"

"That will do, Marie. Go to your room," ordered her father sternly, a strange look in his eyes.

Sobbing as if her heart would break, Marie obeyed.

Chapter Six

Saturday, Marie's wedding day, with the man she hated most in the world, arrived and still no Billie. She had told him over the 'phone of the scene in the study, and he had told her that he would not fail her. She couldn't find out just what he intended to do. He said he didn't know himself, but he said not to worry. She was trying to follow his advice, but still the day past on in an agony of misgivings and suspense. What if he failed her in the last minute?

At 8 o'clock that night a maid, who by the way was a new addition to the household and supplied by Russell, arrayed Marie in her wedding finery and told her that she looked too sweet for anything.

Marie choked back a sob as she entered the study. She shuddered when she saw Russell smiling at her.

Professor Straus seemed ill at ease and seemed to be laboring under a severe strain. It seemed as if he was trying to do or say something and was unable to find the proper words to express himself.

The preacher arrived and still no Billie. Heavens, would he never come? In an agony of fear Marie saw the hands of the clock stand quivering at five minutes to nine. If Billie did not come inside of five minutes she was lost.

"Well, Marie, guess it is time for the wedding," said the professor. "It's nearly 9 o'clock."

Like one in a dream, Marie found herself facing the preacher, felt Russell reaching for her hand and then heard the question:

"If any one knows a reason why this marriage should not be carried on let him speak or forever hold his peace."

Suddenly Marie opened her eyes with a start, for a deep, full-chested man's voice had shouted:

"Yes, I do! Stop the marriage!"

She gave a glance at the study door and then fainted dead away. Standing there, a sneer on his handsome face was Billie Hoyt, not a boy of six in knickerbockers but a full-grown man of twenty-one, and by the look in his eyes, ready for battle.

Russell stared at him dully and stooped to pick up Marie. Billie was ahead of him, however, and shoved him aside as easily as a puny child.

"Get out of the road, grandpa," he sneered. "Let a man pick up his own promised bride."

Russell's face flushed red with anger. With a snarl he struck at Billie. There seemed something wrong. He gave a groan and dropt into the easy chair. Marie handed him a glass of water, which he drank greedily. What in the world was coming over him? Ten minutes before he had felt the stream of youth go coursing through his veins, felt strong and happy; now he felt sick and shaky, felt some strange foreboding. He glanced at the mirror. His voice croaked out.

"Billie Hoyt, what have you done to me? Look at me! I am an old man."

Billie laughed. "That's why I called you grandpa. Listen to what I've got to tell you before you have your man James carry you home. When you doped me up you thought that you had put me out of the way for good. I knew better, after I had taken that elixired kitten and had seen it come out from under the influence of that stuff and inside of five minutes, grow old and die. I know then that in order to keep young you must keep taking that stuff. You didn't know that. Well, I took Marie into my scheme and had her remove the elixir from the laboratory and put some other green fluid in the test tubes. Instead of getting your drops of elixir, you have been taking green water. Besides that I found a neutralizer for the elixir, and when Marie gave you that glass of water a minute ago, you drank it. So good-night, Russell, you had better get home while going is good."

"Professor, I brought a marriage license along with me, and Marie and myself will be married within ten minutes. Tomorrow the elixir will leave you, and things will be as they should be."

"Thank God for what you have done, Billie," exclaimed the professor gratefully. "That man Russell had me under his will-power."

"I knew that something was wrong with you, father, or you would never have tried to make me marry Russell."

"Go ahead and marry her, Billie, and may God bless you both. As for me, my children never again will I fool with the elixir. I've learned a lesson. It is one I'll never forget. Don't try to trifle with the laws of the universe."

[THE END.]

Man-Made Falls Develop 100,000 H. P.

(*Continued from page* 981)

a head of 168 feet at a speed of 200 R. P. M. The generators develop current at 4,000 volts potential, which is later stept up thru transformers to 100,000 volts for transmission over copper wires many miles in length.

At the receiving points along the line, the current is stept down thru transformers, and then converted into direct current by means of motor-generators, as shown clearly in the accompanying illustration.

The total horse-power developed by this plant would require over 100,000 horses, filling a road extending from New York to Boston, a distance of 185 miles air-line.

Millions of Horse-power Going to Waste at Niagara Falls

From Niagara River but 26 per cent. of the total flow is diverted for generating electricity. Engineers estimate that 60 per cent. might be diverted without marring the scenic beauty of the falls.

There is practically no variation in the flow of this river throughout the year, making it ideal for hydro-electric development. Millions of horse-power are now going to waste. A treaty with Great Britain limits the amount of power that can be developed now.

After ten years of contention and a serious drain on the coal and oil fields throughout the country, the door has been thrown open for "white coal" to serve industry and the home by the signing of the water-power development bill. The vast water-powers of the country may now be utilized, says C. D. Wagoner, of the General Electric Company.

Fifty million horse-power comprises the total, both steam- and water-generated, now in use in the United States. It is conservatively estimated that as much more can be developed by utilization of the water power resources. The Department of the Interior has placed the potential water power at 60,000,000 horse-power of which but 10,000,000 is now developed. This saves the country upwards of 33,000,000 tons of coal annually.

Assuming that a steam-produced horse-power generated daily for only 12 hours thruout a period of twelve months represents the consumption of five and one-half tons of coal, the substitution of 50,000,000 horse-power from water should make an annual saving of 275,000,000 tons of fuel and avoid the movement of 7,000,000 freight cars. The economic gains, if we made use of our falling waters, would be tremendous, yet there is in service today but 10,000,000 horse-power developed by hydro-electric plants.

Cannot Substitute for Coal in All Cases

It is not contended that water power can entirely take the place of coal. In some instances a substitution for "black coal" cannot be made, but as a supplement it will add greatly to the total, pull down the average cost per unit, set electricity to work in the home far more extensively than at present.

Dr. Charles P. Steinmetz, chief consulting engineer for the General Electric Company, who amazed the world a short time ago by his map and figures showing the total water power of the country, compiled by checking up the total rainfall with the various elevations of the United States, warns against too general a belief that the power of our water may ever completely replace the use of coal and oil for power purposes.

Other engineers estimating the effect of the federal bill claim that it will open up at least 4,000,000 horse-power of additional electric energy, and that already about 50 applications for the use of 750,000 horse-power have been filed in Washington. The development of federal water power will, in addition to this, open up 4,000 miles of rivers to navigation.

This is not the whole story of the price we pay for steam traction. Not only are our steam locomotives using up 25 per cent. of all the coal mined in the country yearly, not to mention a great deal of fuel oil, and doing this inefficiently, but the distribution of railway coal requires a tonnage movement amounting to about 20 per cent. of the total revenue-producing freight ton-mileage of our land lines. This is not hard to understand if we recall that there is, first, the coal car's journey from the mine to the railway coaling station; next, the fuel's travel on the engine tender; and then, the mileage of the empty coal car bound back to the colliery and hauled, of course, by steam power. Could the steam locomotive be eliminated, and electric haulage employed instead, we could handle as much freight as we did in 1918, and effect, at the same time a saving of probably 123,000,000 tons of coal.

Opportunity Ad-lets

YOU will find many remarkable opportunities and real bargains in these columns. It will pay you to read and investigate the offerings made every month by reliable firms, dealers and amateurs from all over the country. No matter what you may be seeking, whether supplies, automobile accessories, the opportunity to make money, or anything else, you will find listed here the best and most attractive specials of the month.

Advertisements in this section ten cents a word for each insertion. Name and address must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisement for less than 10 words accepted.

Ten per cent. discount for 6 issues, 20 per cent. discount for 12 issues. Objectionable or misleading advertisements not accepted. Advertisements for the March issue must reach us not later than January 22.

The Circulation of Science and Invention is over 140,000 and climbing every month

EXPERIMENTER PUBLISHING CO., INC., 236 Fulton Street, New York City, N. Y.

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Fords start easy in cold weather. Will run 34 miles per gallon on cheapest gasoline or half kerosene, using our 1920 carburetors. Increased power; styles for all motors; can attach them yourself. Big profits to agents; money back guarantee; 30 days trial; Air Friction Carburetor Co., 1511 Madison St., Dayton, Ohio.

Auto Motor Supplies—Buick, Michigan, Stoddard-Dayton, Cadillac-Overland, E. M. F. Continental and Buda Motors, all types, $50 each and up. Special high-tension, 2 and 4 cylinder magnetos $9.50 each. Electric and gas head lamps, coils, carburetors, air compressors, generators, starters, etc. Write for catalog. Address Motor Sales Dept. (12), West End, Pittsburgh, Pa.

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Boys make a model aeroplane that will fly. Easily made at small cost. Write for circular. Aero Shop, 658½ Hurlbut Ave., Detroit, Mich.

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Don't buy a Bicycle Motor Attachment until you get our catalogue and prices. Shaw Mfg. Co., Dept. 1601, Galesburg, Kans.

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